ILLUMINATING ENGINEERING

JUNE 1955

Featuring

Quantity and Quality Of Interior Illumination

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

FROM THIS

1 This 27-year old classroom which has an illumination level of 15 footcandles is about to be transformed. First step was to repaint it light colors for better reflectance. Now follow the succeeding steps, which were all accomplished in 4 hours.

2 Step two was the mounting of the first Photo-Metric channel at the front of the room.

3 The second Photo-Metric channel is in place and conduit spacer has been quickly installed.

4 After channels are mounted, wiring from terminal blocks through conduit spacers is completed.

5 After existing electrical outlet is tapped, lamps are inserted and tested by being turned on.

6 Diffuser frame and spacer bar are assembled on floor, ready for mounting in hook-on points at sockets.

7 Adjoining diffuser frames are assembled together to complete the diffuser grid.

8 Wākon diffusers are unrolled, pulled through diffuser channel, and held at ends by spring clamp.

TO THIS

9 A complete diffuser installed, high level illumination provided, excessive brightness ratios reduced, ceiling cracks and surface wiring covered, and a visual environment designed for learning gained all in four hours installation time.

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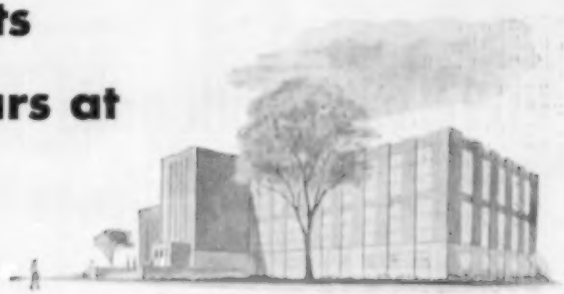
Slimline *lead-lag* ballasts save maintenance dollars at Marquette University



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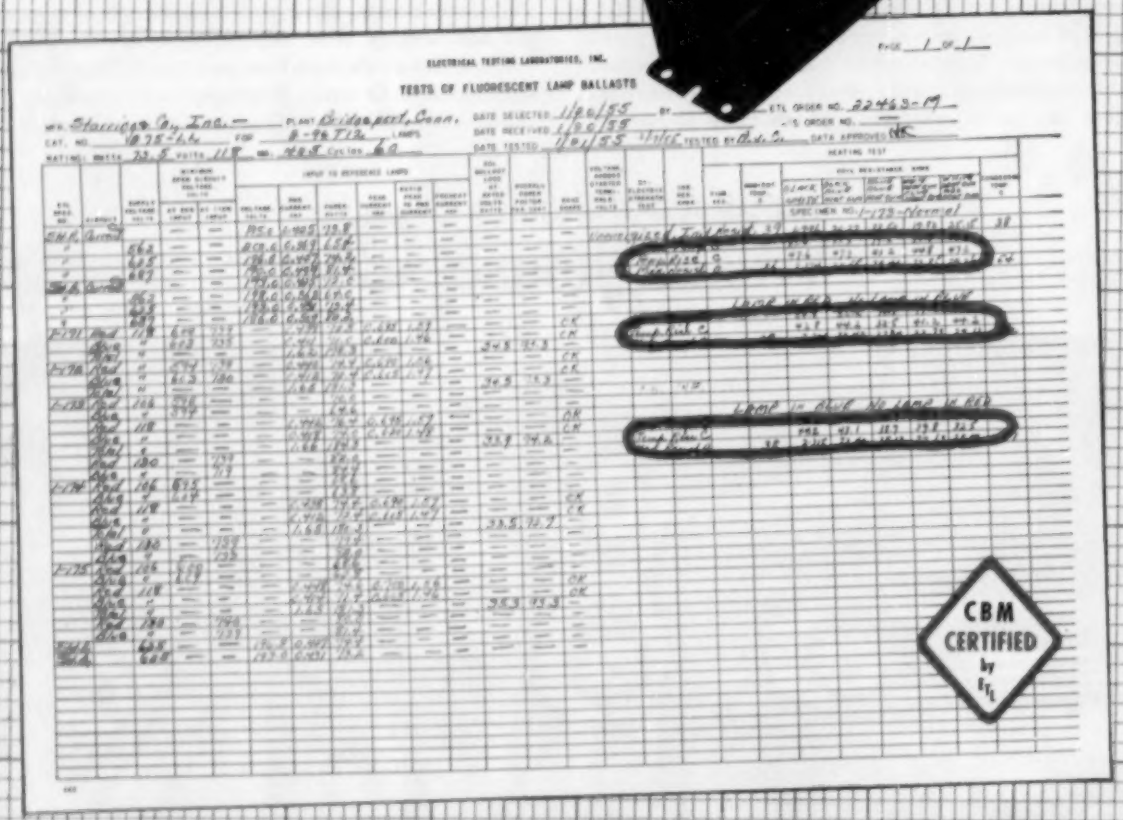

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

JUNE
1955

Vol. L
No. 6

Views and Opinions — The Illuminating Engineer and Jules Verne — T. D. Wakefield — 265

I.E.S. Lighting Data Sheet — Series XX
Lighting a Conference Room (13-77) — 267

Dignity and Warmth for a Church Interior — George C. Schroeder, Jr. — 269

Color and Seeing — Harry Helson — 271

Quality of Lighting — Sylvester K. Guth — 279

Use of Performance Data to Specify Quantity and Quality of Interior Illumination — H. Richard Blackwell — 286

Specialty Lighting — Anytime, Anywhere — 300

The Mercury Vapor Lamp as a Circuit Component — Herbert O. Rost — 302

I.E.S. Lighting Data Sheet — Series XX
Lighting a Railroad Station (19-18) — 307

Lighting Education in Continental Western Europe — W. A. Hedrich — 309

I.E.S. Home Lighting Data Sheet
Soffit Lighting in a Kitchen (22-46) — 315

Lighting a Small Snack Shop — 317

Also: Graduated Levels for "Open-Type" Bank, 299; Lighting the Meeting of the Waters, 314.

TELECAST — Lighting News of Current Interest — 6A
Here and There with I.E.S. Members, 6A and 8A; Lighting Calendar, 33A; About People, 34A; Obituaries, 36A; Books and Pamphlets, 36A; New Members, 36A.

I.E.S. National Technical Conference — 24A

Index to Advertisers — 44A

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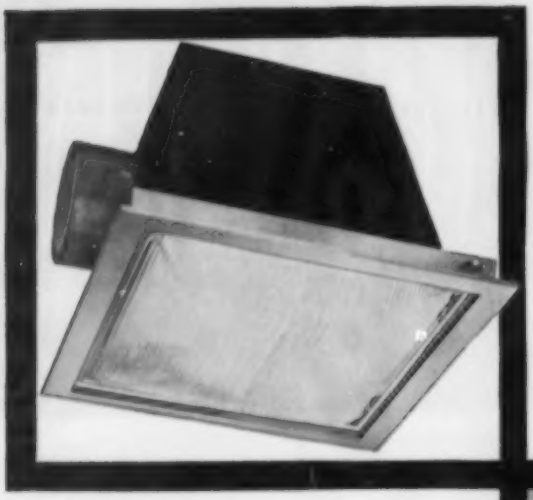

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FOR 150 WATT LAMP

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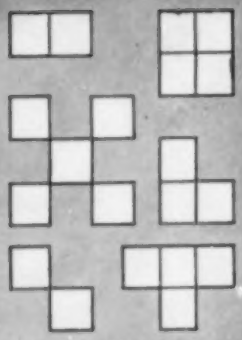
The drawn side of the mounting plate is positioned toward the inside of the housing with the lamp socket to the inside of the mounting plate.



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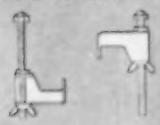

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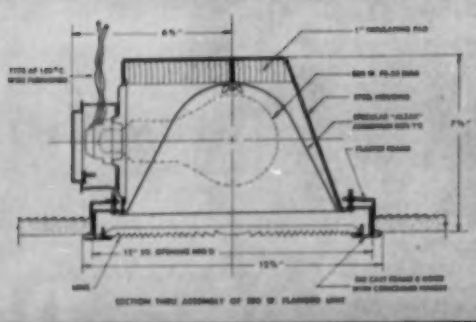

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Views and Opinions

The Illuminating Engineer And Jules Verne

ON THE FIFTIETH anniversary of the death of Jules Verne, this year, it was reported that the pioneer of science fiction made thirteen inspired guesses about the future and got ten of them right.

He forecast the airplane, the submarine, the helicopter, long range artillery, talking pictures, plastics, television, remote control, the atomic bomb, and a voyage around the world in 80 days. Of his other three forecasts, interplanetary flight is on the way and artificial satellites are being planned, but no one has yet attempted to burrow to the center of the earth.

In "Twenty Thousand Leagues under the Sea," the illuminating engineer discovers that Jules Verne also invented the electric translucent ceiling. This adds one more inspired guess about the future which came out right. His prediction of the electric ceiling is all the more remarkable when we recall that "Twenty Thousand Leagues under the Sea" was published in 1869, ten years before Edison developed his first practical electrical lamp, and nine years before the first successful open arc.

Electricity, which plays such an important part in the operation of the fictional submarine Nautilus, was at that time still one of the laboratory curiosities. Indeed, Paris had just seen her first gas street light. Only just now have atomic scientists been able to equal the facility with which Captain Nemo derived the energy to provide propulsion for his submarine. Our Navy's modern counterpart was rightly named in 1954 "The Nautilus."

A description of the lighting in the original (1869) Nautilus starts with Monsieur Aronnax on his entry into the submarine. "I followed Captain Nemo; and as soon as I had passed through the door, I found myself in a kind of passage lighted by electricity, similar to the waist of a ship. I then entered a dining room, decorated and furnished in severe taste. The plate on the table sparkled in the rays which the *luminous ceiling* shed around, while the light was tempered and softened by exquisite paintings."

Monsieur Aronnax must have been greatly impressed by the lighting of the Nautilus for he continues with a description of the library: "*The electric light flooded everything; it was shed from four unpolished globes half sunk in the volutes of the ceiling.* I looked with real admiration at this room, so ingeniously fitted up, and I could scarcely believe my eyes."

Continuing, his description of the next room should still be highly satisfactory to a 1955 lighting specialist: "Captain Nemo opened a door and I passed into an immense drawing room splendidly lighted. It was a vast four-sided room thirty feet long, eighteen wide, and fifteen high. A *luminous ceiling* decorated with light arabesques, shed a soft clear light over all the marvels accumulated in this museum. For it was in fact a museum, in which an intelligent and prodigal hand had gathered all the treasures of nature and art."

For an illuminating engineer with a power company, it is interesting to note how the Nautilus relied upon electricity for the services on board: Captain Nemo said: "There is a powerful agent, obedient, rapid, easy, which conforms to every use, and reigns supreme on board my vessel. Everything is done by means of it. It lights it, warms it, and is the soul of my mechanical apparatus. This agent is electricity."

"Electricity?" I (M. Aronnax) cried in surprise.

"Yes, sir."

"Nevertheless, Captain, you possess an extreme rapidity of movement, which does not agree with the power of electricity. Until now, its dynamic force has remained under restraint, and has only been able to produce a small amount of power."

"Professor," said Captain Nemo, "my electricity is not everybody's. You know what sea-water is composed of. In a thousand grammes are found 96½ per cent of water, and about 2⅔ per cent of chloride of sodium; then, in a smaller quantity, chlorides of magnesium and of potassium, bromide of magnesium, sulphate of magnesia, sulphate and

carbonate of lime. You see, then, that chloride of sodium forms a large part of it. So it is this sodium that I extract from sea-water, and of which I compose my ingredients. I owe all to the ocean; it produces electricity, and electricity gives heat, light, motion, and, in a word, life to the Nautilus."

Jules Verne also recognized the caprice and vagaries of daylight, and our daylighting engineers, even today, would agree with the following: "If electricity does not furnish me with air to breathe, it works at least the powerful pumps that are stored in spacious reservoirs, and which enable me to prolong at need, and as long as I will, my stay in the depths of the sea. *It gives a uniform and unintermittent light, which the sun does not.*"

Industrial lighting is also thought of (perhaps with its 35 per cent upward component?) for Verne continues: "A door opened, and I found myself in the compartment where Captain Nemo had arranged his locomotive machinery. This *engine room, clearly lighted,* did not measure less than sixty-five feet in length. It was divided into two parts; the first contained the materials for producing electricity, and the second the machinery that connected it with the screw."

And as if to predict the dimming of fluorescent lamps with which Captain Nemo (may have) illuminated the luminous ceilings, he writes of how the Nautilus was allowed to sink to an unusual depth: "Some minutes later it stopped at a depth of more than 420 fathoms, resting on the ground. *The luminous ceiling was darkened, then the panels were opened, and through the glass I saw the sea brilliantly illuminated by the rays of our lantern for at least a mile round us.*"

In the last dramatic chapter of "Twenty Thousand Leagues under the Sea," Jules Verne again uses light to add suspense to his story: "The panels had closed on this dreadful vision, but light had not returned to the salon; all was silence and darkness within the Nautilus. . . . At eleven the electric light reappeared. I passed into the saloon. It was deserted. I consulted the different instruments."

This article is being written but a few miles from the birthplace of Thomas Alva Edison, and, of course, this tribute to Jules Verne in no way detracts from the great inventor's luster. His "Edison effect" was a forerunner of the modern fluorescent lamp.

Jules Verne was a novelist who wrote about the future potentials of electric lighting; Edison was the inventor in the laboratory who carried these things out. This bears out what Verne said in his old age: "What one man can imagine another man can do." The world is a better place to live in because of their endeavors in literature and invention.

T. D. WAKEFIELD
Vice-President
The F. W. Wakefield Brass Co.,
Vermilion, Ohio

MMILJ to IES members means "My Most Interesting Lighting Job" — the annual contest, sponsored by the Lighting Service Committee, in the Sections and Chapters, in the Regions, and at the National Technical Conference of the Society.

To identify those interesting installations as entries in the 1955 contests, the insignia above has been devised as a "recognition-spot" for articles in IE which had their origin as My Most Interesting Lighting Jobs in this year's competitions, such as those on pages 314 and 317, this issue.

The Lighting Service Committee is under the chairmanship of Lee Tayler; committee members are William T. Clark and Paul H. Hildebrand.

INSTALLATION AT DAIRYLAND POWER COOPERATIVE, LA CROSSE, WISCONSIN.

Lighting a Conference Room

LIGHTING OBJECTIVE: To provide 100 footcandles of comfortable general illumination in a board of directors' room.

GENERAL INFORMATION: The board of directors' room in this new office building measures 36 feet 2 inches by 40 feet 3 inches by 8 feet 5¾ inches and is decorated as follows:

ceiling	off-white	50% RF
walls		
wallpaper	brown and gold	14% RF
plaster	cream	57% RF
draperies	pistachio with gold interweave	
floor	light rubber tile	30% RF
doors	white oak, driftwood finished	24% RF
tables	medium walnut	9.5% RF
chair upholstery	light green plastic	59% RF
	yellow	67% RF

(over)

A.I.A. File No. 31

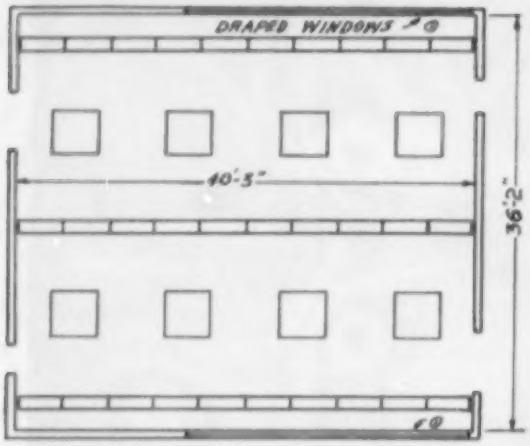

Figure 2. Plan view showing location of lighting equipment.

INSTALLATION: Fig. 2 shows the location of all lighting equipment. The large square units are Garcy #7895/6 4 foot x 4 foot recessed troffers with egg-crate louvers; each contains six 40-watt white rapid start fluorescent lamps and three 2-lamp lead-lag ballasts. The continuous row units are Westinghouse #1569675 Type TU-80WR with prismatic glass covers: each contains two 40-watt white rapid start lamps and one lead-lag ballast.

Average maintained illumination on the main table top is 109 footcandles, with 103 footcandles at the center of the room. The lowest illumination measured on a corner table, is 90 footcandles. Brightnesses are as follows:

Walls	
North (wallpaper)	11 ft-L
South (plaster)	27 ft-L
West (plaster)	41 ft-L
East (wallpaper)	11 ft-L
(plaster)	30 ft-L
Draperies	14 ft-L
Floor	33 ft-L
Table top	14 ft-L
Doors	18 ft-L
Ceiling	16-19 ft-L
Luminaires	
Row units	
at 16°	450 ft-L
at 27°	438 ft-L
Square	
at 9°	250 ft-L
at 20°	275 ft-L

Lighting engineer: Cliff Ryan of the Dairyland Power Cooperative; architect: William Ingemann and Assoc., St. Paul, Minn.

Lighting data submitted by Robert L. Allen, Division Engineer, Westinghouse Lamp Division, Minneapolis, Minn., as an illustration of good lighting practice and to aid in the design of similar installations.

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Series XX 6-55

Solution to the lighting problem of St. Matthew's Lutheran Church, New Orleans, is unconventional. Like the architectural design of the building itself, however, it is in keeping with the

Dignity and Warmth For a Church Interior

By GEORGE C. SCHROEDER, JR.

PROBABLY the most extreme feature of this church design was its total building budget — $55,000 including the lighting. Nevertheless, it was the aim of the lighting plan to provide unobtrusive illumination, in keeping with both the budget and the dignity, reverence and warmth of the interior.

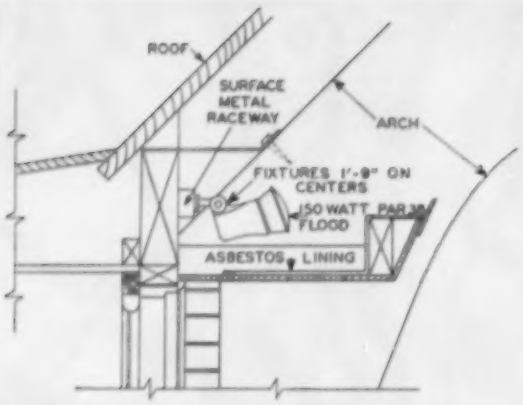
Cove lighting is, of course, conventional enough in a manner of speaking, though often hardly inexpensive. This cove lighting system, however, departs from convention considerably. Further, in its execution it was quite inexpensive and very efficient as well. It accomplishes the aims of good church lighting, and at the same time provides a very respectable 13 footcandles on the pews.

AUTHOR: Design Engineer for Louis N. Goodman and Associates, Consulting Electrical Engineers, New Orleans, La. ARCHITECTS: Dreyfous, Seiferth and Gibert, New Orleans, La.

This is no traditional cove. We do not light a narrow band of ceiling — or attempt to light a wider band at an inefficient grazing angle. In our cove we have placed 150-watt PAR-38 flood lamps in adjustable aluminum holders mounted on No. 3000 series wiremold so that the lights in the cove on one side of the church light the acoustic tile ceiling on the opposite side in cross-fire fashion. This produces a uniformly lighted ceiling as well as a uniform distribution of light at pew level.

Architectural design of the church did not permit the coves to be continuous into the chancel or into the balcony, so the whole problem was not as yet solved. In order to keep the lighting on the ceiling over the balcony at the same level as the ceiling over the nave, adjustable hooded fixtures were installed on the walls.

In the balcony the lighting has a two-fold pur-



PAR-38 floods in adjustable aluminum holders are mounted so that lights in cove on one side of the church light the ceiling on opposite side, in cross-fire fashion.

pose. Besides their normal use, four of the fixtures are connected to a time clock to light the rear section of the church at night, thus silhouetting the large cross on the church exterior, a pleasing sight to passersby.

The chancel offered the greatest problem. Bracketed fixtures on the walls, as were used in the balcony, would be a distraction. For the chancel, adjustable hooded fixtures are mounted on the chancel side of the laminated wood arches. One fixture on each side is directed at the ceiling, one at the altar, and three at the crucifix, which is an impressive 16 feet in height. Colored roundels are used on the fixtures directed at the crucifix — three amber on one side and one amber and two reds on the other side. These roundels add warmth to the aluminum crucifix and the use of two colors serves to bring out the three-dimensional value of the sculpture without producing harsh or unnatural shadows.

Summary

A. The lighting was within the budget:
   1. Wiring costs were held to a minimum.
   2. The total cost of fixtures and lamps to light the Nave, Chancel and balcony was only $297.00 less than six-tenths of one per cent of the total cost of the project.

B. The job is efficient because:
   1. The main reflecting surface is white.
   2. No special lens or reflectors are necessary.

C. There is no glare.

D. The maintenance is simple because:
   1. The lens part of the lamp is almost vertical.
   2. The fixtures are easily accessible for relamping.
   3. As is common to PAR lamp installations, new reflectors and lenses are obtained with each new lamp.

E. Architectural features are enhanced since:
   1. Building features are accentuated at night.
   2. Third dimension effect of crucifix at altar adds to the sculpture.

In practice, it succeeds in the aims of good church lighting — drawing immediate attention to the altar, and providing uniform illumination without distraction from either fixtures or deep shadows. Further, it pleases the architects and the congregation, and stands at a landmark to those who pass at night.

Time-clock controls lighting in balcony to silhouette the large cross on the church exterior, producing this effect at night.

Color and Seeing

By HARRY HELSON

WHILE a great deal is known about the quantity and distribution of light necessary for efficient and comfortable visual performance, not very much is known about the effects of color, or spectral energy distribution of light sources, as they affect vision. The problems center not so much in the nature or specification of sources of light as in the peculiar and intricate nature of the visual mechanism. How to combine a given type of illuminant with the visual mechanism to yield optimal visual functioning requires consideration of many factors which enter into any given set of conditions in which the eyes are the primary determiners of behavior. Although the criteria for assessing the adequacy of light sources are not very numerous, *e.g.*, color rendition, visual acuity, comfort and efficiency of vision, the number of visual functions by which they may be evaluated is extremely large. Many studies have been made of various visual functions with lights of different spectral energy distributions but it is difficult, if not impossible, to draw conclusions from them because of the conflicting results. Failure of equally competent investigators to obtain consistent results regarding the effects of illuminant colors on visual function springs in large part from the failure to recognize and take into account important factors in the viewing situation and in the nature of the visual mechanism which may influence the results. It is the purpose of this paper to clarify some of the possible sources of variance among different investigators and to indicate what may or may not be done with respect to them.

Individual Differences in Color Vision

It is common practice to speak of "the color" of light sources as well as of objects as if colors were as constant as hardness or weight of objects and then to assume that "the color" of the source were the same for everyone. While the majority of individuals with normal color vision will agree within fairly narrow limits on what "the color" of an object is under specific conditions of viewing at least 25 per cent of the population see object colors quite differently from the majority as shown by the data in Table I. The data are from 16 "normal" observers highly trained in reporting the exact hue of colored papers. The papers were viewed under Palo daylight illumination against a gray surround and consisted of 15 standard Munsell chips representing six different hues. From Table I it is seen that while about 75 per cent of the observers reported the same hue for a given sample, the other observers reported different hues, some seeing a component to one side of the predominant hue, others seeing the component on the other side of the main hue. Thus R 3/7 which was reported as unitary (pure) red by 12 of the 16 observers was seen as a yellowish-red by three observers and as a bluish-red by one observer. Similarly, G 3/4, which was reported as unitary green by 11 observers, was seen as a yellowish-green by two observers and as a bluish-green by three observers. In the case of P 3/6 the 16 observers divided about equally into three groups of which one group saw equal amounts of red and blue in the "purple," the second group saw more blue than red in the color, and the third group saw more red than blue in the

TABLE I.—Hues of 18 Munsell Colors as Reported in Palo Daylight Illumination by 16 Observers.

(Letters indicate hues as follows: red, R; yellow, Y; green, G; blue, B; purple, P; achromatic, A. Small letters indicate minor components such as yellowish-red, yR.)

(From H. Helson, *Amer. J. Psychol.*, 52, 406, 1939).

Samples	R	yR	RY	rY	Y	gY	YG	yG	G	bG	BG	gB	B	rB	RB	bR	A
R 3/7	12	3														1	
R 5/10	10	5														1	
R 7/6	13	2														1	
YR 4/5		1	4	9	2												
Y 5/7					10	6											
Y 7/8					15	1											
G 3/4								2	11	3							
G 5/7								3	13								
G 7/7								4	11	1							
B 3/5												6	10				
B 5/6												7	9				
B 7/4											1	1	14				
P 3/6														6	5	5	
P 5/6															10	6	
PB 7/4													16				
A 10/0																	16
A 5/0																	16
A 0/0																	16

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 13-17, 1954, Atlantic City, N. J. AUTHOR: The University of Texas, Austin, Texas.

TABLE II.—Range of Changes in Colors Representative of the 10 Munsell Major Hues in Passing from Daylight to Three Fluorescent Sources of Illumination.

(The colors red, green, yellow and blue are denoted by R, G, Y, and B; numerators indicate lightness with 0 and 10 as endpoints; denominators indicate saturation with 16 maximal.)

(From H. Helson, D. B. Judd and M. H. Warren to be published.)

Daylight (Munsell Notation)	6500K	4500K	3500K
4.0 R 4.9/5.3	5.5 R 5.4/6.8 3.0YR 4.4/4.8	9.3RP 4.9/10.8 3.0YR 4.4/4.8	9.3RP 5.4/9.8 3.0YR 4.4/5.8
5.5YR 6.9/10.1	5.0YR 6.7/11.9 10.0YR 7.7/7.9	5.1YR 6.7/10.9 7.5YR 6.7/8.9	5.0YR 7.7/14.9 2.5 Y 5.7/9.9
5.5 Y 7.9/12.3	5.0 Y 6.1/9.7 7.5 Y 8.1/15.7	5.0 Y 8.1/15.7 10.0 Y 8.1/8.7	7.5 Y 6.1/16.7 10.0 Y 7.6/8.7
5.0GY 7.6/9.5	5.5GY 7.1/11.5 3.0 G 6.1/9.5	5.5GY 6.6/13.5 10.0GY 6.6/8.5	5.5GY 7.1/6.5 3.0 G 8.1/9.5
5.0 G 4.9/8.2	3.5 G 5.1/6.6 6.0 G 5.6/6.6	1.0 G 5.1/13.6 6.0 G 6.6/8.6	1.0 G 5.6/12.6 6.0 G 6.6/11.6
9.5BG 3.2/5.8	4.3BG 3.5/4.8 0.5PB 2.5/2.8	8.0BG 2.5/3.8 4.2 B 3.0/9.8	1.7 B 2.5/4.8 9.2 B 1.5/4.8
5.0 B 5.0/6.8	4.0 B 6.3/10.6 6.5 B 5.3/8.6	9.0BG 5.3/12.6 6.5 B 4.3/8.6	4.0 B 3.3/6.6 9.0 B 4.3/5.6
4.0PB 5.3/6.2	4.5PB 4.9/4.0 4.5PB 5.9/7.0	2.0PB 5.9/6.0 8.3PB 6.9/9.0	2.0PB 5.9/8.0 8.3 P 4.9/6.0
5.0 P 6.1/9.1	3.0PB 7.5/9.1 8.0 P 5.5/9.1	8.0PB 6.0/9.1 3.0RP 6.5/10.1	3.0 P 6.5/8.1 3.0RP 5.5/15.1
4.5RP 6.3/8.4	0.5RP 7.9/5.8 5.5RP 6.9/7.8	0.5RP 6.9/7.8 9.2RP 6.4/8.8	0.5RP 5.9/8.8 1.7 R 6.9/8.8

"purple." We would expect similar differences among observers if a group of individuals was asked to judge the color of a source of light.

In a recent study of the color rendering properties of fluorescent sources of illumination by Helson, Judd and Warren (1955) individual differences in color vision proved to be as striking as the ones found earlier under Palo incandescent daylight illumination. In Table II are given the extremes of the range of hues reported for representative samples of the 10 major Munsell hues by five observers. Again we find that different people see different colors even when the light reaching the eyes is the same for all observers. Thus 9.5 BG was seen as blue-green by one observer and as purple-blue by another observer with 6500K fluorescent light as the source. Whether or not a given illuminant will be acceptable to an individual will depend, therefore, upon what colors he sees in the illuminant and this, in turn, will depend not only upon the physical characteristics of the source but just as importantly upon the properties of the individual's own visual mechanism.

It might seem plausible to assume that the "whiter" a source of light the smaller would be the differences among individuals in the way object colors are seen but the data in Table II show that the range of colors reported in the whitest of three sources, 6500K fluorescent, is as great as the range of colors reported by five observers in 4500K and 3500K. The extent to which object colors change in artificial light from their daylight appearance depends as much upon the individual as upon the spectral energy of the source, and, as we shall see, even more importantly upon the background against which they are viewed. We cannot hope, therefore, to reduce disagreement among different observers as to the colors of objects simply by controlling the spectral energy of the illuminant. Individual differences will be less when all viewing conditions, including the source, are the same for all observers.

Individual differences in color vision have been ascribed to differences in macular pigmentation, to differences in the transmissivity of the various ocular surfaces and media, and to variations in sensitivity of the color receptors themselves. It might also be thought that differences in color vision are due to the method of observation or report, or to failure of observers to employ color names in identical fashion when reporting the colors they see. Undoubtedly these and other factors are operative but similar differences are found under the most refined conditions of visual research and even in direct color matching to a standard (*Cf.* Halsey and Chapanis, 1954). In fact the more refined the method of measuring color vision the more certainly do differences appear. Thus the trilinear coordinates of the best white which three trained observers were able to synthesize through mixture of the red, green, and blue lights in a colorimeter were: $x = 0.269 \pm 0.026$; $y = 0.269 \pm 0.040$; and $z = 0.462 \pm 0.057$ (Helson and Michels, 1948). The variation among observers was about 10 per cent which is well above threshold for any one of them. Thus one cannot assume that a light source which is yellowish-white to one individual will function as a yellowish source for another if their sensitivities happen to differ. In determining the effect of color in an illuminant it is therefore necessary to take into account the particular sensitivities of the individuals who are tested or will work in it. This is especially necessary in experimental studies involving at best very small samples of the seeing population. Too often, the fact of individual differences in color vision has been neglected in dealing with the effects of spectral energies of light sources.

Background Effects

What effect color in the source of any illuminant will have on visual function, whether it be on rendition of colors, visual acuity, comfort or efficiency, depends as much upon the background and the average of all reflecting surfaces in the field as

upon the quantity and quality of the light emitted by the source. This fact is strikingly brought out by the data presented in Table III wherein the colors of 19 daylight achromatic samples are reported in practically monochromatic red light on daylight white, gray, and black backgrounds. Although the light falling on and reflected from the 19 samples was red, the samples had different hues and saturations on the three backgrounds due to the action of the visual mechanism. On the black background the predominant hue was red, the color of the light emitted by the source, with a bluish component tinging the samples of medium and low reflectances. On gray background, samples above 15 per cent reflectance were perceived as red or bluish-red, samples between 11 and 15 per cent reflectance were perceived in their daylight achromatic color, while samples below 11 per cent were seen as predominantly green with a bluish component. On white background, only the lightest samples were perceived as red, while samples of 34 to 39 per cent appeared in their daylight color of light gray, and the remaining samples were blue, except for the darkest ones which were a mixture of blue and green.

At first sight the data in Table III appear difficult to interpret but they yield a generalization of very wide significance which is applicable not only to strongly chromatic illuminants but also to weakly chromatic sources. This generalization has been called the principle of color conversion by the writer and can be stated as follows: "In any viewing situation the eye establishes an adaptation-level such that objects having reflectances (or brightness) above adaptation-reflectance (or brightness) are tinged with the hue of the illuminant, objects below adaptation-reflectance are tinged with the hue of the after-image complementary to the hue of the illuminant, and objects at or near adaptation-reflectance are either achromatic (black, white, or gray) or weakly saturated hues of uncertain color" (Helson, 1938). From Table III it is seen that the background largely determines the adaptation-level or reflectance since the samples reported achromatic on white background have reflectances from 34 to 39 per cent, on gray background from 11 to 15 per cent, and on black background 3 per cent. The eye is therefore capable of neutralizing even monochromatic light through adaptation as shown by the samples reported neutral on the three backgrounds. The eye also has the power to "pump in" hues which are not correlated with corresponding radiant energies as in the case of the blue and green hues reported in monochromatic red light (Table III).

Since the adaptation-level is all-important in

TABLE III.—Colors of 19 Daylight Achromatic Samples Viewed on Three Backgrounds in Monochromatic Red Illumination.

(Numerator indicates lightness and denominator indicates saturation on a 0-10 scale.)

(From H. Helson, *J. Exp. Psychol.*, 23, 448, 1938).

Reflectance	RED ILLUMINANT		
	White Background	Gray Background	Black Background
0.80	R 9.0/0.5	R 8.5/7.0	R 7.0/7.0
.52	R 7.0/1.0	R 7.5/6.0	R 7.0/7.0
.39	A 6.0/0.0	bR 6.0/3.0	R 6.0/7.0
.34	A 6.0/0.0	bR 6.0/3.0	R 5.0/5.0
.27	B 6.0/1.0	RB 6.0/3.0	bR 5.0/5.0
.23	B 5.0/2.0	RB 5.5/2.0	bR 5.0/5.0
.22	B 5.0/3.0	RB 5.5/2.0	bR 4.5/4.5
.17	B 5.0/4.0	RB 5.0/1.0	bR 5.0/4.0
.16	B 5.0/4.0	RB 5.0/0.5	bR 4.0/4.0
.15	B 5.0/5.0	A 5.0/0.0	bR 4.0/4.0
.13	B 5.0/5.0	A 5.0/0.0	bR 4.0/4.0
.13	B 5.0/5.0	A 5.0/0.0	bR 3.0/4.0
.11	B 5.0/5.0	A 4.0/0.0	bR 3.0/4.0
.10	B 5.0/5.0	bG 4.0/0.5	bR 2.0/2.0
.07	B 4.0/6.0	bG 4.0/1.0	bR 1.0/1.0
.07	B 4.0/6.0	bG 3.0/3.0	bR 1.0/1.0
.05	B 4.0/6.0	bG 3.0/3.0	bR 1.0/1.0
.03	gB 4.0/6.0	bG 2.0/5.0	bR 1.0/0.5
.03	BG 3.0/7.0	BG 1.0/8.0	A 0.0/0.0

determining the color of objects it is desirable to evaluate it quantitatively. Adaptation-reflectance has been found to be a weighted geometric mean of all reflectances in the field of view and can be closely approximated by means of the formula:

$$A_r = (R_s R_b^3)^{1/4} \qquad (1)$$

or in log form:

$$\log A_r = (\log R_s + 3.0 \log R_b)/4 \qquad (2)$$

where A_r is adaptation reflectance, R_s is the mean of the object reflectances in the field, and R_b is the reflectance of the background. In cases where a uniform background does not exist, surfaces should be weighted according to their areas. Since these formulae refer only to reflectance or its closely associated measure, brightness, the state of chromatic adaptation can be approximated by taking a weighted mean of the trichromatic coefficients of all objects and areas in the field of view so that formula (1) becomes:

$$x_A = (\bar{x}_s + 3.0\, x_b)/4 \qquad (3)$$

$$y_A = (\bar{y}_s + 3.0\, y_b)/4 \qquad (4)$$

where x_A and y_A are the C.I.E. trichromatic coefficients representing the chromatic adaptation of the eye, $\bar{x}_s$ and $\bar{y}_s$ represent the average chromaticity coefficients of all objects in the field of view, and x_b and y_b represent either the chromaticity coefficients of the background, if a uniform background exists, or a weighted mean of the chromaticity coefficients of large areas in the field of view.

Since x_A and y_A specify the chromatic adaptation of the eye, they actually specify the achromatic point for any viewing situation. It is immediately

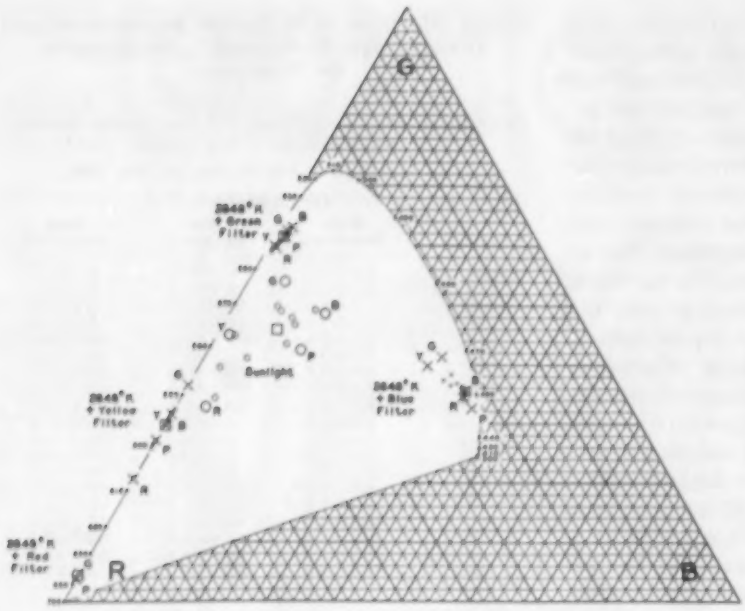


Figure 1. Seventy-five illuminant sample combinations represented on the uniform-chromaticity scale Maxwell triangle. The samples with Abbot-Priest sunlight as the illuminant are shown by circles; those for the four strongly selective illuminants (red, yellow, green, blue) are shown by crosses. The illuminants are indicated by squares. (From D. B. Judd: "Hue Saturation and Lightness of Surface Colors with Chromatic Illumination," *J. Res. Nat. Bur. Standards*, 1940, *24*, p. 310, RP 1285.)

apparent that x_A and y_A will depart more and more from commonly accepted white or achromatic points such as average daylight, sunlight, Illuminant C, etc., the more the illuminant and/or objects in the field, particularly large areas, shift the achromatic point of the eye away from these usual states of adaptation. Such shifts in the achromatic point of the eye explain the fact that a daylight yellow surface seen in sodium vapor light, which is almost monochromatic, is seen not as yellow but as *white*. If the usual practice of taking the distance of the sample point from the daylight achromatic point in the C.I.E. mixture diagram is followed, one erroneously concludes that the yellow surface in monochromatic yellow should look yellow. However, in this situation since x_A and y_A are very close to, if not identical with, the illuminant and sample points, the distance of the sample point from the achromatic point is null or very small, and therefore the sample on this analysis should look achromatic, which it does. Reference to Fig. 1 illustrates how the chromaticity coefficients of objects "follow" the illuminant points and how the chromatic adaptation of the eye shifts with radical changes in spectral energy of the illuminant. It is apparent that if the achromatic point of the eye is close to the illuminant point, as is the case with monochromatic and strongly chromatic illuminants, hue and saturation will not correlate with C.I.E. dominant wave-length and purity since these are determined by reference to different "white" or neutral points. The concept of adaptation-level furnishes the actual achromatic point of the eye for specific conditions of light source, background and object reflectances in the field of view.

While quantitative determination of the achromatic point of the eye in accordance with Equations (1), (3), and (4) is necessary in order to specify the state of the visual mechanism for all types of illuminants, it needs to be supplemented by the principle of color conversion if background effects on color are to be accounted for. Object colors above, near, and below adaptation-level behave differently and the principle of color conversion gives an indication of the direction of change in object colors with changes in visual adaptation as a result of background and other factors. Accurate prediction and specification of color requires that the facts expressed in the principle of color conversion, as well as other facts, be incorporated into quantitative approaches to color. Already several studies have appeared in which background and adaptation effects receive quantitative treatment (Judd, 1940; Spencer, 1943; Helson and Michels, 1948; and others). It appears that prediction of object colors in different sources of illumination is possible by taking into account adaptation to the illuminant color (Helson, Judd, and Warren, to be published). Further advances will come with deeper understanding of the nature of the color mechanisms of the eye but first it is necessary to order the phenomenological data and to correlate them with the spectral energies giving

rise to them. Recognition of the overwhelming influence of background on adaptation should help to remove one of the most important sources of variance in visual science.

Object Colors and Color of Source of Light

That the spectral energy of light sources affects the colors of all parts of the visual environment is a fact of common experience. One senses the color of the source of light through its effect on object colors even when the source itself is hidden from view. The color of the source of light is a sort of common denominator for everything seen. Reference has already been made to the fact that object colors "follow" the light source as shown in Fig. 1. The 75 points in Fig. 1 representing 15 Munsell colored papers in five illuminants show how the colors of all objects are influenced by the chromaticity of the illuminant. Large shifts in the chromaticity coefficients and their corresponding colors are also found in passing from daylight to weakly chromatic sources such as 2854K tungsten filament and 4500K and 3500K fluorescent sources. But important as the spectral energy of sources may be, reflectance of background is of equal importance, as shown in Table III where it is found that the same papers in one illuminant have different colors when viewed against different backgrounds. The effect of spectral energy of the source of light must therefore be considered always in connection with the relation of specific object reflectances to the average reflectance of the whole visual field.

To try to state which of the trinity of factors determining visual function — light source, spectral reflectance of objects, or the visual mechanism — is most important is like trying to say whether the hen or the egg came first. Once it is recognized that perceived colors and the comfort and efficiency of vision depend upon all of these factors the mistake should not be made of ever considering them isolated from one another. Obvious as is this analysis of the seeing situation, one has only to look at some of the most modern lighting installations to find that the lighting was designed without regard to the average chromaticity coefficients of the objects, walls, ceilings and floors lighted by them. Just as the impedance of a loud speaker in a radio set must match the impedance of the circuit feeding into it for best results, so the spectral energy of light sources must be considered in relation to all reflectances in the field of vision and the properties of the visual mechanism.

No one source of light can bring out all object colors to best advantage. If some colors are accentuated, others will necessarily be reduced, and almost all objects will change more or less with change in spectral quality of light sources. So-called color constancy, the tendency of object colors to withstand wide changes in intensity and smaller changes in spectral energy of sources of illumination, is limited. And due to color conversion, objects with reflectances above the average of the field (adaptation-reflectance) tend to be tinged with the hue of the source while objects below the average tend to be tinged with the after-image complementary to the hue of the source. Proper choice of color (chromaticity and luminous reflectance) of large areas in the field of vision may lower adaptation-reflectance sufficiently so that the hue of the illuminant predominates in most object colors and a single visual effect can be had from a given light source.

It is not easy to make valid generalizations regarding the effect of illuminant color on object colors beyond the first-order approximation expressing the direction of color changes in the principle of color conversion. Owing to the fact that adaptation has a double effect, desensitization to strong portions of the spectrum with concomitant greater sensitivity to complementary spectral regions, resultant object colors seem unpredictable. Nevertheless certain regularities are observable such as the shift toward the color of the illuminant and gain in saturation of object colors not far from the illuminant color and shift away from the illuminant hue, often with gain in saturation, of complementary object colors. Thus in passing from Illuminant C (approximation to daylight) to incandescent filament illumination, purple and red-purple become much redder while blue-green becomes greener, the loss of blue helping to accentuate the illuminant hue in the one case and the complementary hue in the other case (Helson and Grove, 1947; Helson, Judd, and Warren, 1952). When these effects of adaptation are embodied in quantitative treatments of the color rendering properties of illuminants good predictions of the effects of spectral energy of sources on object colors are possible.

So far as visual adaptation on object colors is concerned the types of spectral energy distribution, *i.e.*, continuous *vs.* discontinuous type of source, makes no difference. For most practical purposes it does not matter what radiant energies are responsible for a given state of adaptation. This is fortunate because an infinite number of different spectral distributions may give rise to the same state of visual adaptation. However, discontinuous energy sources, such as fluorescent lamps, may change object colors unduly because any one of the

strong lines in such sources may be accentuated so that object colors depart from their daylight appearance. When foods and complexions are affected individuals complain. People do not like greenish-yellow butter or bluish-white potato or rice. The author can refer to a personal experience in this regard which remains very vivid after several months. He chose an order of fried chicken in a cafeteria because of the golden-brown color of the chicken in the show case but when he found it to be a greenish-yellow color at the table his appetite for it considerably diminished. The illumination in the show case was a rich reddish-yellow from a filament lamp of low color temperature but the light from the ceiling where the food was eaten was a whitish-blue from a fluorescent bank of lamps! The fact that such color changes are now understood and can be predicted means that we are in a fair way to control lighting for satisfactory color rendition under most circumstances.

Effects of Color of Source on Acuity and Other Visual Functions

Statements concerning the effect of color in the source of light on acuity and efficiency of vision range all the way from denial of any effect to claims of superiority of white light, or sodium vapor light, or even mercury vapor light. From their survey of the literature, Simonson and Brozek (1940) concluded that there existed a "state of confusion in the appreciation of the importance of the spectral quality of light" and they attributed the contradictory results in the published studies chiefly to the failure to appreciate the complexity of visual functions involved in the majority of industrial jobs. Since we are here concerned with the color factor let us limit ourselves to what would now seem to be the main sources of discrepancy among investigators regarding the effect of spectral energy of sources on visual performance by discussing only factors influencing color although we recognize fully the important role of other factors, such as brightness ratios and distribution of light in the environment.

In the main, conflicting results regarding the role of color of the illuminant on visual performance are probably due to the fact that this was the only variable under investigation with the result that other factors were neglected. Our discussion of background effects on color has shown that color effect of the illuminant depends as much on background and object reflectances as it does upon the light emanating from sources. We have no assurance that different investigators employed the same backgrounds when studying the effects of various

TABLE IV.—Intensity Necessary for Maximal Saturation.

(From data obtained by D. McL. Purdy quoted by L. T. Troland, *Principles of Psychophysiology*, Vol. II, D. Van Nostrand Co., New York, 1930, p. 169.)

Hue	Wavelength	Intensity (photons/9)
Red	700	4.66
Violet	440	1.00
	460	1.33
Blue	470	1.66
Blue-Green	480	2.66
	490	2.11
Green	505	6.90
	515	9.44
	525	17.20
Green-Yellow	540	21.44
	555	20.20
	565	24.37
Yellow	575	19.44
Orange	585	14.90
	592	7.11
	600	5.44
	620	6.33
	635	4.00
Red	660	4.90

sources of light so that inter-comparisons can be made meaningfully. Differences in average chromaticity and reflectance coefficients among the different experimental environments could account for many of the conflicting results in the literature.

It has been customary when comparing sources having different spectral energy distributions to equate them for brightness but not for chromaticness. Various regions of the spectrum achieve maximal saturation at different brightnesses as shown in Table IV. If we take the amount of light required for maximum saturation of violet as unity, green requires from 7 to 17 units saturation, green-yellow from 21 to 24 units, yellow 19 units, orange from 4 to 15 units and red 5 units. Furthermore it cannot be said that yellow at its maximal saturation is as saturated as maximally saturated blue. The reason, therefore, for the often-quoted superiority of yellow light (sodium) over other colored lights (mercury, tungsten filament) may be due to the fact that even though the sources were equated for luminance, the yellow was actually less chromatic (saturated) than the others! As yet no studies have been made of acuity, recognition time, speed of reading and of manipulatory performances, blink rate and fatigue with chromaticness of light sources equated with or without equating luminance. Until this is done the effect of illuminant color on visual functions cannot be clarified.

Another source of difficulty in attempting to gauge the effect of spectral quality of illuminants on performance is found in the fact that various measures of visual function do not correlate highly with each other even under identical conditions of observation. Thus it is not true that if a given

type of lighting reduces visual recognition time that it will also reduce accommodation or convergence near points or that the condition yielding the lowest absolute photopic threshold will also result in the highest visual acuity. Visual functions, while mediated by the same set of organs, seem to be more or less independent. With footcandle levels the same for three different illuminants, Simonson and Brozek (1948) found no significant differences in blinking rate or number of correct letters reported but they did find differences among the illuminants in critical fusion frequency and recognition time. In line with these conflicting findings they found that some ophthalmographic tests showed significant differences among the illuminants (velocity and deviation of the eyes from targets) while others did not (near points for accommodation and convergence). Their conclusion, that if level of illumination gave significant differences in a function then spectral quality also gave significant differences, must be regarded as a highly important guide for further investigations of the effects of spectral quality of illuminants on visual functions.

Differences among investigators may also arise from the fact that even when the same function is measured under otherwise identical conditions, the method of measurement may influence the result. It is known, for example, that the binocular septum method of measuring color adaptation increases color differences as compared with binocular adaptation to one type of light at a time. There is hardly any measure of human performance which cannot be made in a variety of ways and it must be recognized that the method of measurement is a variable capable of influencing the quantity measured (*Cf.* Sperling and Farnsworth, 1950).

Monochromatic sources of light, such as the sodium vapor lamp, have been thought to increase visual acuity by reducing the blur circles on the retina arising from chromatic aberration of the refracting system of the eye. This effect must, however, be balanced against another, equally important effect, namely, that visual acuity also depends upon the number of receptor elements (cones) activated by the light and this number depends importantly upon the intensity and probably also on the wavelength of the impinging light. If some populations of visual receptors are more sensitive to certain wavelength bands and less sensitive to others, then the purer the light beam the fewer will be the number of receptors functioning, and the coarser will be the retinal mosaic for picking up details. One effect must therefore be balanced against the other in choice of light sources.

So far we have considered spectral quality of illuminants only in terms of acuity, efficiency, or performance measures of visual function. But it is becoming increasingly evident that comfort and aesthetic factors are also very important whether or not visibility or acuity are affected, as Guth (1951) has maintained. While brightness contrast is most important for visual acuity and visibility very few people care to work in an environment entirely devoid of chromatic contrasts. If it is not possible to provide chromatic variation in the working or living environment by the use of colored walls, ceilings, work benches or machinery, the lack may be made up through the use of mildly chromatic sources of illumination since even non-selective (black, gray, white) surfaces are tinged with color in accordance with the principle of color conversion. One of the advantages of the tungsten filament lamps is the warm emotional tone produced by the strong red and yellow components in their spectral energy curves. For generations artists and stage designers have called red and yellow "warm" colors because of their pleasant emotional effects. With increase in the long-wave components of fluorescent lights the more modern sources should compete with tungsten lamps in this respect. But much more work will have to be done on emotional, motivational, and other "subjective" effects of illuminant colors before safe generalizations can be made in this area as well as in the more objective but equally difficult areas of efficiency, acuity, and performance measures of visual functions.

Is There a Best Color for All Sources of Illumination?

Attempts to prescribe or to define the best spectral quality for sources of illumination are bound to fail because no one spectral energy distribution can serve all purposes best. Specific color qualities in illuminants may be desirable for specific purposes. If it is desired to maximize differences among the largest number of colors, then a white type of light is best as shown in Fig. 1 where the 15 Munsell samples spread out most in sunlight and cluster more and more around the illuminant point as its light becomes more and more monochromatic. The largest range of color qualities will be seen in "white" light. But if it is desired to maximize differences between certain selected hues, as in grading fruits for canning, then the chromatic adaptation should be intermediate between the hues of the colors being discriminated as shown in a study by White (1949). Since it might be difficult to obtain illuminants plotting between the hues of various products, backgrounds having

the desired colors would serve equally well, perhaps better, for controlling the adaptation-level. Quantitatively White's principle may be expressed as follows:

$$x_g = (x_1 + x_2)/2 \quad (5)$$

$$y_g = (y_1 + y_2)/2 \quad (6)$$

where x_g and y_g refer to the chromaticity coefficients of the background against which the samples, x_1, y_1 and x_2, y_2 are viewed. The optimal background reflectance or luminance would be:

$$Y_g = k(Y_1 + Y_2)/2 \quad (7)$$

where the Y's refer to the reflectance or luminance of background and samples being compared, and k is a constant between 0.35 and 0.45 for most viewing conditions.

Since practical interests and purposes change as new needs arise it is necessary to have a fundamental understanding of all factors in the viewing situation in order to come up with answers to them. For example, in 1943 Farnsworth, Reed and Shilling found that deutanous and milder protanous (color deviant) individuals detected more pseudo-isochromatic plates in yellowish, tungsten light than in daylight. If it is desired to pass a somewhat larger number of color deviant individuals for restricted types of military duty where their deficiency will not be of importance, then the use of this light source, formerly thought to be deleterious, is to be recommended. On the other hand, if strict standardization in giving color blindness tests is the main consideration, then daylight types of sources would be in order and new criteria of passing the tests would have to be established if a larger proportion of testees is to be passed. Another example of changing standards is to be found in the higher color temperatures of lamps for grading cotton which now prevail as against earlier color temperatures. While the visual mechanism does not change, its use as an instrument may be modified to meet new requirements.

The Brighter Side of the Picture

From the foregoing discussion the reader may conclude that only the visual specialist is capable of handling specific problems of lighting. The situation is not quite as bad as it seems for once the complexities of visual functioning are understood, measured and controlled it becomes possible to cope with them. In spite of the intricacies of visual function, and we have by no means dealt with them all, the eye is a very stable instrument due to its extraordinary powers of adaptation. It can function over enormous ranges of light intensities (50 million million to one according to one authority) and from completely monochromatic to completely heterochromatic light. By changing level of adaptation large changes in luminance and chromaticity are compensated to a great extent and differential sensitivity remains fairly constant. Hence objects tend to keep their daylight colors in yellowish tungsten light, in various fluorescent illuminants, and over wide ranges of intensity of illumination. Certainly no single optical instrument or photographic emulsion can duplicate all of its functions as well as the eye itself performs. Only when special problems or specific situations calling for special solutions arise does it become necessary to prescribe specific types of spectral energy in the iluminant. With the progress that has been made in the last few years in understanding how colors are seen the future looks very bright so far as effects of illuminant colors on seeing are concerned.

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Quality of Lighting

By SYLVESTER K. GUTH

THE ULTIMATE GOAL of lighting practice is to provide brightnesses in the entire visual environment which produce the most satisfactory seeing conditions in terms of visual performance, ease of seeing, safety and comfort. That is, the brightnesses of the task and its surround should be such as to permit a worker to achieve optimum performance with maximal ease of seeing. Furthermore, the brightnesses of other more remote areas should be in balance with the task brightness so that the worker will be visually comfortable. When this is accomplished, we can say that quality of lighting has been achieved.

This desire for quality of lighting is not new; countless writers have emphasized its need. In his inaugural address, L. B. Marks, the first president of our Society, stated that there was no question needing more attention than that of unshaded or inadequately shaded lamps. Others have emphasized the need of controlling all brightnesses in the visual field. Unfortunately, the limited available experimental evidence, much of which was concerned with disability or loss of perception, forced upon us rather empirical methods of dealing with glare. During the past forty years or so a number of technical committees have considered this problem. However, their conclusions were based upon studies of lighting materials and methods of their day and are not readily applicable to modern lighting techniques.

The demand today is for a method of evaluating lighting equipments and systems that is based upon a sound foundation. From a practical viewpoint we do not want to be too restrictive nor too lenient in our limitations on the brightness relationships for comfortable seeing. In general, we are past the necessity of considering only disability glare. Experience has told us that brightnesses which may produce no significant loss in ability to see are, nevertheless, uncomfortable. The higher footcandle levels of today provide greater visual sensitivity — we can see things better and easier. It seems entirely logical that this increased visual sensitivity has also made the user of light more sensitive to environmental brightnesses and brightness relationships. Therefore, it is up to the illuminating engineer to review certain of his practices to make sure that he is making every effort to achieve his primary objectives.

This paper presents a brief review of where we now stand with regard to quality of lighting, some of the newer experimental data, and the several methods that have been proposed for evaluating comfort. Since the entire subject of quality of lighting is too broad to be covered by a brief paper, this is confined primarily to discomfort produced by sources of brightness such as luminaires. The exclusion of other factors involved in quality of lighting, such as reflected glare, is not intended to minimize their importance. It is believed that these various aspects of the problem can be considered separately to determine how each must be dealt with in actual lighting practice.

S.Q.Q. Committee Report No. 1

Just ten years ago the Committee on Standards of Quality and Quantity for Interior Illumination presented Report No. 1, *Brightness and Brightness Ratios.*[1] This was perhaps the first real attempt to develop relatively complete brightness relationships that could be considered recommendations of our Society. During this period we have had considerable opportunity to determine whether its specification of brightness ratios was satisfactory. Almost from the beginning there have been pro and con viewpoints. Some have believed that the ratios were unnecessarily restrictive while others felt that the ratios should be adhered to implicitly. Consequently, there have developed various interpretations and extensions of the ratios which often result in considerable confusion as to just what constitutes good lighting practice.

Of the four specifications of brightness ratios proposed in Report No. 1, there seems to have been little or no dissent from those dealing with the visual task and its immediate surround. For "best" and "good" seeing conditions, ratios of unity and three, respectively, were recommended. Experimental evidence indicates that these ratios are sound. Such relationships are relatively easy to obtain and they agree with experience.

These same ratios of unity and three were recommended for a light source or luminous portion of a luminaire to its background. It was pointed out

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that there were conditions, such as for small area sources, for which ratios greater than three would be permissible between the source and adaptation brightness. However, to the writers of that report it "appeared desirable, for the present, at least, to specify the same limiting brightness-ratio as in the case of the visual task." Thus, great emphasis was placed upon the ratios of unity and three for all areas in a visual environment.

Report No. 1 was based largely upon the experiments of Holladay.[2] Because of the limited range of variables he investigated — especially the size of source — it was necessary to extrapolate his data to include luminous areas comparable to those used in present day lighting practice. Furthermore, he provided no information regarding how much brighter sources could be if they were removed from the line of vision. Some of the limiting brightness values calculated by the Holladay formula did not seem to agree with experience. In spite of this, Report No. 1 did accomplish several things. It did much towards raising the general standard of lighting practice by illustrating the general relationships among some of the factors which influence comfort and discomfort. Furthermore, it emphasized the gaps in our knowledge which needed to be filled before we could develop a more complete basis for evaluating the relative comfort of typical lighting systems.

New Experimental Data

During the past several years three groups have made major contributions to our basic knowledge of discomfort glare.[3,4,5] It is outside the scope of this paper to present detailed information on these investigations; nevertheless, it is pertinent to review briefly the extent of the studies and to compare the results.

Criteria and Procedures — The criteria used in the three studies, while not identical, are sufficiently similar to show that the investigators were striving for the same goal. That is, the emphasis was on minimizing discomfort. Vermeulen and deBoer in Holland had their observers adjust the brightness of a source to a value "considered to be the limit above which an increase would cause a transition from comfort to discomfort." The Luckiesh-Guth observers adjusted the source brightness until it produced a "visual sensation at the borderline between comfort and discomfort." This was termed the BCD sensation. In a later experiment,[6] the criterion of "just barely distracting" was included. In England, Petherbridge and Hopkinson used a multiple criterion technique in which the observers were asked to assess discomfort from the glare source in terms of

"A. Just intolerable — the changeover point between intolerable and uncomfortable glare.

"B. Just uncomfortable — the changeover point between uncomfortable and merely distracting glare.

"C. Just acceptable — the changeover point between distracting and acceptable glare.

"D. Just imperceptible — the changeover point where *glare* from the source is just no longer noticeable; the sources themselves are still noticeable, but they merge into the general field of view in such a way that they no longer form any source of attraction."

A consideration of these diverse criteria seems to indicate that there is a difference in degree between those used by Vermeulen and deBoer and by Luckiesh and Guth. The former gave somewhat more emphasis to comfort than to discomfort, whereas the latter gave equal emphasis to the two sensations. The multiple criterion technique of Petherbridge and Hopkinson brackets the other two.

The general procedures by each group differ markedly. In the Petherbridge-Hopkinson studies the observers adjusted the surround brightness until the source produced the prescribed sensation. In other words, the observers were subjected to a continually changing adaptation brightness which could have an important effect upon the results. In the other investigations, the source brightness was varied by the observer and the surround brightness maintained constant for a given series of observations.

The European investigators exposed the sources continuously, whereas the Americans used a momentary exposure of the source. However, it has been reported[6] that there was no significant difference between prolonged and momentary exposure for the BCD sensation. The latter has been found to be particularly convenient for making comparisons and to relate certain experimental situations to a standard condition.

There always is a question as to whether data obtained in laboratory situations can be applied directly to actual lighting systems. Any fundamental investigations must be made with controlled conditions in order to determine the relative effects of the many factors that are involved. To accomplish this, Petherbridge and Hopkinson used a small scale arrangement. While this was convenient, it did raise the question of correspondence to full scale arrangements. However, they recently reported[7] the results of a comparative test

which showed no significant differences between them. Luckiesh and Guth did most of their fundamental work in an 80-inch hemisphere, but extended it successfully to include a larger scale simulated room[6] and several typical lighting installations.[8] Vermeulen and deBoer used only a laboratory set-up which included a square source located at various positions above the line of vision.

Experimental Results—All three groups studied the basic factors which govern whether sources of brightness are visually comfortable or uncomfortable. The ranges included by each are presented in Table I. Empirical equations have been developed to represent the relationships among source brightness B, source size ω, and adaptation brightness F.

$$\text{Vermeulen-deBoer}: B = C\,\frac{F^{0.6}\,\theta^{0.9}}{\omega^{0.3}} \qquad (1)$$

$$\text{Luckiesh-Guth}: B = M\,P\,F^{0.44}\,(\omega^{-0.21} - 1.28) \qquad (2)$$

$$\text{Petherbridge-Hopkinson}: B = K\,\frac{F^{0.6}}{\omega^{0.5}} \qquad (3)$$

In Equations (1) and (2), θ and P, respectively have been included to take into account the greater permissible brightnesses for sources the farther they are displaced from the line of vision. Petherbridge and Hopkinson did not include source displacement, suggesting that neglecting this factor would incorporate a "factor of safety." C, M and K are constants, their specific value being dependent upon the visual sensation or degree of discomfort involved.

Size of source — At first glance, Equation (2) seems to be considerably different from (1) and (3) because the size of source ω does not appear in the denominator. However, the complex parenthetic expression has the same effect as though it were. Certain similarities and differences among these equations are illustrated by Fig. 1. Values of B have been calculated for a surround brightness F of 10 footlamberts, a source displacement of 10 degrees above the line of vision and various values of source size. The Petherbridge-Hopkinson curve is for their sensation "B."

TABLE I.—The Range of Variables Studied by Different Investigators.

Factor	Vermeulen-deBoer	Luckiesh-Guth	Petherbridge-Hopkinson
Source Brightness (Footlamberts)	Variable**	Variable**	60-4500
Source Size* (Steradians)	0.00005-0.083	0.0001-0.13	0.00027-0.027
Source Position (Degrees)	13-48 Vertical	0-60 Vertical 0-70 Diagonal 0-100 Horizontal	4-70 Vertical 4-16 Horizontal
Surround Brightness (Footlamberts)	0.12-15	1-100	Variable**
Groups of Sources	No	Yes	Limited
Immediate Surround of Source	No	No	Limited
Shape	Yes	Yes	Yes

*Typical lighting systems generally involve areas greater than about 0.025 steradian.
**Controlled by the observer while other factors are fixed for a given series of observations.

The ranges of source sizes used by each group overlap only partially, the largest ones being included by Luckiesh and Guth. Size of luminous area is an important factor and it provides the major link to actual lighting equipment. Harrison[9] has pointed out that most fluorescent lighting installations involve areas greater than 0.025 steradian. Thus, they generally would be above the sizes used by Vermeulen and deBoer and by Petherbridge and Hopkinson. Therefore, their relationships require extrapolation in order to apply them to many lighting systems, an objection that has been raised regarding the use of Holladay's data.

When the size of source is relatively small — less than about 0.01 steradian — the Vermeulen-deBoer relationship is approximately parallel to the Luckiesh-Guth curve. In other words, an increase in luminous area requires the same relative

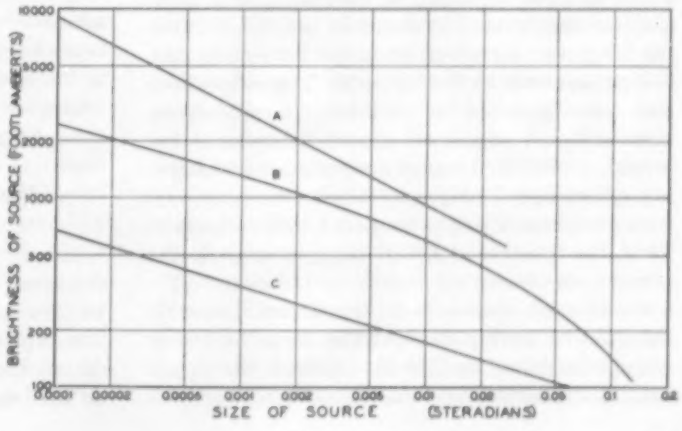

Figure 1. The relationships between brightness and size for sources located 10 degrees above the line of vision and a surround brightness of 10 footlamberts as determined by Petherbridge and Hopkinson (A), Luckiesh and Guth (b) and Vermeulen and deBoer (C).

TABLE II.—Relative Brightnesses of Sources Located Various Distances Above the Line of Vision for a Constant Visual Sensation.

Angle	Vermeulen-deBoer	Luckiesh-Guth	Petherbridge-Hopkinson
0	—	1.0	1.0
10	1.4	1.5	1.4
20	2.4	3.2	1.8
30	3.5	3.3	2.4
40	4.6	5.3	4.6
50	5.6	9.2	8.8
60	—	16.9	24.3

reduction in source brightness to maintain a constant visual sensation. The lower brightnesses obtained by the former indicate that their criterion of comfort-discomfort probably was more comfortable than the Luckiesh-Guth BCD sensation. Of course, other factors, such as observers having a greater sensitivity to brightness or being more critical of glare, could account for the difference.

On the other hand, the Petherbridge-Hopkinson data plot as a steeper curve. This indicates that, as the size of source is increased, its brightness must be reduced more rapidly. A possible explanation for their steeper curve may be that their primary variable was surround brightness *F*. However, their relationship is parallel to a tangent to the Luckiesh-Guth curve at about 0.02 steradian. The difference in brightness indicated by the two curves in this region would lead to the inference that the BCD sensation is between their sensations "B" and "C."

Surround Brightness — A second apparent difference in the equations is in the exponent used for surround brightness *F*. The relative effects of exponents of 0.6, 0.44 and 0.3 are that doubling *F* permits increasing *B* by 52, 36 and 23 per cent, respectively. At the moment there is no obvious explanation for these differences. They probably are caused by differences in experimental procedures and techniques. If the values obtained by the Europeans are considered extremes, the Luckiesh-Guth exponent of 0.44 may be a good median value to use. It should be pointed out that the brightest surround used by Vermeulen and deBoer was only 15 footlamberts. This is less than that usually found in practice. In application these different exponents should not present too serious a problem because generally several lighting systems producing very nearly the same surround brightness will be compared with each other. Thus, the function of *F* will be approximately the same in all cases.

Position of Source — An important factor is the effect of moving sources away from the line of vision. Luckiesh and Guth explored the upper half of the visual field and determined the relative brightnesses of sources located in this region which would produce the BCD sensation. The other investigators studied vertical displacements of sources and obtained similar results as shown in Table II.

Petherbridge and Hopkinson reported no significant differences between vertical and horizontal displacements out to 16 degrees, the extent of their study. On the other hand, Luckiesh and Guth found their observers to be considerably more sensitive to horizontally displaced sources. For example, at 20 degrees from the line of vision, diagonal and horizontal BCD brightnesses were 20 and 40 per cent less, respectively, than the vertical BCD brightness. At greater angular displacements the differences are even more marked. This greater horizontal sensitivity to brightness agrees with experience.

Groups of Sources — It is extremely important to know how to combine the effects of each of a group of sources to determine their overall effect on comfort. Petherbridge and Hopkinson, in their limited experiment found that glare effects from up to four sources in view were not directly additive, but that the effect was somewhat less than those computed from observations with a single source. However, for simplicity, they suggested that if arithmetic additivity were assumed, it would introduce a factor of safety to calculations. The individual sources in a group were not widely dispersed in order to minimize effects due to their angular separation. This, and their manner of presenting results in terms of surround brightness, make it difficult to relate their findings to practice.

Luckiesh and Guth studied a number of different combinations of sources in the original BCD investigations. It was found that the sum of the individual indices of sensation was not consistent or relatable to experimental data. In other words, glare effects are not directly additive. However, they did find a simple and practical equivalent for multiple sources to be the total of the individual areas located at the position of the source closest to the line of vision. That is, the individual solid angles are added and the sum is used in Equation (2). Only the position index *P* of the source closest to the line of vision is used. Calculations using this method have shown good agreement with experimental results.

The foregoing brief review and comparison of the newer experimental data make it evident that we now have considerably more information than was available to the first S.Q.Q. Committee. We do not know the why of some of these effects, but do have some knowledge of what happens and how

the factors should be balanced to provide visual comfort. More data are needed, particularly regarding multiple sources and the influence of brightness of the ceiling against which sources are viewed.

Methods of Calculating Comfort Ratings

In order for the illuminating engineer to be able to evaluate the comfort of a lighting system, he must have a mathematical method which will give proper relative weight to the many factors that are involved. Probably the first method for doing this was suggested in S.Q.Q. Report No. 1. Fowler and Crouch[10] had concluded previously that the Holladay formula offered a "logical and concise method of predicting the limiting brightness of luminaires or luminous areas. . . ." However, they were not able to devise a means for determining the total glare effect of all the luminaires in the field of view. Later, Crouch[11] presented in some detail the method referred to in Report No. 1. Briefly, his method involves a relatively complicated method of converting the luminaires in a lighting system into equivalent zones around the one which is assumed to be fixated by an observer. These incremental annular zones combine to form an equivalent disk subtending a solid angle for which, by the Holladay formula, the limiting brightness is calculated. The ratios between this limiting brightness and the brightness of the system determines the relative comfort of the installation.

Unfortunately, the Holladay data are limited in scope, especially with respect to size of source and its position in the visual field. Any method based upon his data cannot be applied to most modern lighting systems without considerable extrapolation. Therefore, the method suggested in Report No. 1 and by Crouch has never been used to any extent.

To overcome some of the limitations, a number of others have proposed alternate methods for evaluating the discomfort produced by sources of brightness. Since they have been presented in detail elsewhere, they will be described only sufficiently to illustrate their characteristics, assumptions involved, and their differences.

Glare Rating Method— About a year after S.Q.Q. Report No. 1 was published, Harrison presented his Glare Rating Method.[12] As originally devised, it was based upon the Holladay data plus such modifications that seemed to be indicated to make it applicable to modern lighting equipments. He pointed out that certain assumptions were involved and that it probably would be modified as newer information became available. During recent years a number of refinements have been incorporated in the original method[13] and a routine technique for applying it has been developed by Meaker.[14]

The basic equation for the calculation of glare factors (G) as now used is

$$G = \frac{A_p B^2 (LC)}{SF} \qquad (4)$$

in which A_p is the projected area of the source, LC is a location coefficient, and SF is a surround factor which incorporates wall brightness and background brightness of the source itself. The equation may be rewritten in a form similar to the experimentally determined formulae:

$$B = N \frac{F^{0.5}}{\omega^{0.5}} \qquad (5)$$

in which F corresponds to the surround factor, ω to the projected area; N is a constant which includes the glare factor and location coefficient.

It has been found that a glare factor (G) of about 55 corresponds to average BCD as determined by Luckiesh and Guth. Calculated values of B for the same condition used for Fig. 1, are compared with Luckiesh and Guth's data in Fig. 2. It is seen that the glare factor brightness plot is an approximate tangent to the Luckiesh-Guth curve at about 0.025 steradian. Differences between the two are relatively small for a reasonable range of solid angles in this general region. In other words, for sources within a relatively limited range the glare rating method will rate sources approximately the same as the BCD method. However, larger or smaller sources will be rated as being more comfortable than is indicated by experimental data. Since most fluorescent systems other than relatively large luminous ceilings generally fall within this range, the glare rating method should be satisfactory.

Groups of sources are dealt with simply. The glare factor for each unit is calculated and the sum of the individual values is the rating for the entire group. Tables have been prepared which present the ratings for typical equipments used various sizes of rooms. They serve to aid in estimating the probable ratings that would be obtained with similar luminaires. Of course, calculations should be made for specific systems to obtain a more accurate rating.

The Glare Rating Method has served a very useful service. Even though small areas might be rated as being more comfortable than they actually are, the same method — including assumptions and inaccuracies — is applied to all lighting systems.

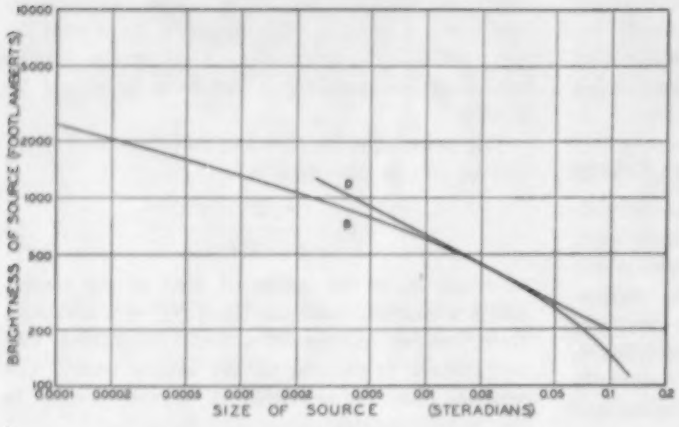

Figure 2. A comparison of the relationships between source brightness and size as determined by the Glare Rating equation (d) and as obtained by Luckiesh and Guth (B).

Thus as a means of comparing two installations, generally similar except for luminaire brightnesses, it should be reasonably adequate and accurate. However, two systems which differ considerably in luminous areas cannot be compared accurately beyond placing them in their appropriate comfort categories.

BCD Method — The method of dealing with groups of sources developed from the basic data merely involves using another form of Eq. (2):

$$M = \frac{B}{P F^{0.44} (\omega^{-0.21} - 1.28)} \qquad (6)$$

in which M becomes an index of sensation or rating of comfort-discomfort. The sum of the individual solid angles is substituted for ω and the position factor of the luminaire closest to the line of vision is used for P. The BCD method has been checked in tests involving a simulated room[6] and with actual lighting systems.[8] Calculations using it have shown the agreement with experimental results to average about 5 per cent. The total solid angles included in these comparisons ranged from 0.001 to 0.13 steradian, which encompass the majority of typical lighting systems.

The major comment on this simplified method of rating comfort involves the manner in which sources are combined. In effect, equal weight is given to each of two identical sources located at different positions in the visual field. However, the position indices that were experimentally determined for single sources at various positions do not seem to hold when groups of sources are involved. Until revised position indices have been obtained, this seems to be the best way to apply the experimentally determined BCD equation. It is interesting to note that the BCD method corresponds to the suggestion of Petherbridge and Hopkinson that the effect of displacements up to 50 degrees be neglected. Their equation was determined in terms of sources located 10 degrees from the line of vision. This is about the displacement of the more distant sources in medium and large rooms.

Logan-Lange Method — These authors[15] have devised a graphical method by which all lighting units within the visual field are summated into a single source that is considered to be their equivalent. Their basis is that the areas of sources of equal brightness are additive. They convert each source of a lighting system into an equivalent one located on the line of vision and having a common brightness. The solid angles for these converted sources of equal brightness are determined graphically from a Visual Comfort Chart which is based upon the Luckiesh-Guth data. The sum of these new solid angles is taken as the size of the single source which will produce the same visual sensation as the original group of sources. Again using the Visual Comfort Chart, they determine the average BCD brightness for this converted equivalent source. The ratio between the brightness to which the sources have been converted and the BCD brightness is considered a measure of the visual comfort of the installation.

This is a unique approach to the evaluation of the comfort or discomfort produced by lighting systems. The method of converting the individual sources of brightness to equivalent ones on the line of vision appears to be valid. However, this transformation can be accomplished more precisely by means of the Luckiesh-Guth formula (Equation 6). The main point to question is the method of combining these converted sources. Using this method, calculations have been made for a number of the Luckiesh-Guth experimental situations. In most cases it was found that the Logan-Lange method rated the groups of sources as being more

comfortable than had been indicated by the experimentally determined evaluations. It seems logical to assume that an empirical evaluation method should be relatable to research findings.

Visual Comfort Index — A recent significant forward step has been the development of a better method of presenting comfort-discomfort evaluations. It is obvious that an arbitrary numerical rating scale which has no real significance is difficult to comprehend. To overcome this objection the original data obtained by Luckiesh and Guth with 50 observers has been used to determine how many of the observers would be expected to be visually comfortable with a given combination of environmental conditions. The application of this to the BCD data was described in a previous paper.[8] It now has been applied to the Glare Rating Method[16] and also to the Logan-Lange Method.[17] That is, the BCD index of sensation M, the glare factor G, and the Logan-Lange ratio are expressed in terms of a Visual Comfort Index or the probable per cent of observers who would be expected to be comfortable. The relationships among the ratings of each method and with the Visual Comfort Index are presented in Table III. Table III indicates that low values of ratings are imperative for a high degree of comfort. As comfort increases (higher visual comfort index) glare ratings decrease more rapidly than the BCD and Logan-Lange ratings. In effect, the different numerical values are similar to using various temperature scales for describing the boiling point of water. Presenting evaluations in terms of a visual comfort index makes it considerably easier for the user of light to understand the significance of such ratings.

The Future

This brief review of what has been done — experimentally and empirically — during the past ten years should be encouraging. Progress is being made towards placing certain aspects of quality of lighting on a sound basis. Perhaps we are not moving forward as rapidly as some would like. But by not overextending ourselves we can be reasonably sure that our mistakes will be few and our errors small.

TABLE III.—Table for Converting Ratings into Visual Comfort Indices.

	Increasing Comfort →					
Visual Comfort Index	25	40	50	60	75	90
Glare Rating	91	66	55	45	31	15
BCD Index of Sensation	135	119	108	98	80	55
Logan-Lange Ratio	126	110	100	90	75	51

The present methods for evaluating the relative comfort produced by luminaires appear to be fairly satisfactory. However, each has certain limitations which make it difficult to apply to all situations. In spite of this, indications are that all will rate a series of lighting installations in the same order of relative comfort.

Our hope is for an "I.E.S." method. It should be one that is universally applicable, simple and practical to use and include the visual comfort index method of presenting evaluations. Furthermore, it should involve minimum empiricisms and assumptions. This means that we need more data on how to deal with groups of sources. Such an experiment is now underway. The fairly good agreement between the present evaluation methods and experience leads us to believe that the effect of these data when they are available will be moderate. One need be no great optimist to feel that our future is "bright" and "comfortable."

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Use of Performance Data to Specify Quantity and Quality of Interior Illumination

By H. RICHARD BLACKWELL

THIS PAPER is the third in a series of papers presented to the Illuminating Engineering Society concerned with the specification of interior illumination. In the first paper,[1] an experimental study of brightness discrimination was reported, and a brief description was given of the use of brightness discrimination data to specify the quantity of interior illumination. In the second paper,[2] general problems involved in specifying the quantity and quality of interior illumination were discussed. The present paper contains descriptions of methods of using basic visual performance data to specify the quantity and quality of illumination, the brightness discrimination data reported in the first paper being used to illustrate the methods. General conclusions with respect to illumination specifications are compared with conclusions reached by Weston[3] and by Moon and Spencer.[4]

General Aspects of the Illumination Specification Problem

Visual performance continues to be one of the two primary criteria upon which the specification of interior illumination is based, the other being visual comfort. Visual performance is defined in terms of the speed and accuracy of performing visual tasks under interior illuminations of interest. An entirely adequate specification of illumination requires sets of visual performance data as a function of quantity and quality of interior illumination, for all visual tasks of interest. Once such data are available, interior illumination can be specified to fulfill any desired criteria of speed and accuracy of visual performance.

Unfortunately, obtaining the required sets of performance data for all visual tasks of interest is scarcely feasible. It seems reasonable, instead, to select certain fundamental visual tasks as indicative of other visual tasks, and to obtain complete relations between speed and accuracy of performing these tasks and the quantity and quality of illumination. Then, devices may be developed for identifying visual tasks of practical interest with one or more of the fundamental visual tasks.

This specification procedure is believed by the author to be superior to the other systems currently proposed for specifying interior illumination. Weston's[3] performance data represent an arbitrary combination of speed and accuracy data, obtained on only one visual task. It should be noted, however, that the Landolt broken rings used by Weston are probably indicative of many practical visual tasks of interest. Moon and Spencer's[4] Delos method represents an arbitrary index of visual performance relative to performance at high illumination levels, obtained on only two visual tasks. The method is based in no way upon data representing the speed and accuracy of visual performance, and there is no way in which it can be referred to these criteria of visual performance. The Luckiesh-Moss Visibility Meter[5] is a device for evaluating relative performance for practical tasks, in terms of performance for one fundamental visual task. Speed and accuracy are not employed at any point in the process of using or calibrating the Visibility Meter. All these systems have the limitation that only one or two visual tasks are used as the basis for specifying illumination. In none of them are the two criteria of performance treated separately, so that quantity and quality of illumination may be specified for any desired combination of these performance criteria.

Unfortunately, complete data relating speed and accuracy of performance to quantity and quality of illumination are not at present available even for a single visual task. Data relating speed and accuracy of visual performance to quantity of illumination were reported by the author in the first paper of the present series. In the present paper, methods are described which make it possible to evaluate the effect of quality of illumination upon speed and accuracy, utilizing these data and well-known relations in "disability glare." Thus, the present paper contains the first example

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of a complete illumination-specification system for both quantity and quality of illumination along the lines proposed by the author.

The Visual Performance Data

It will be well to summarize the experimental conditions under which the visual performance data to be utilized in the paper were collected. Observers were required to detect the presence of a circular test object, hereafter referred to as the "target." The target consisted of a uniform luminance (brightness) increment presented on a prevailing field of uniform luminance. The prevailing field was uniform in luminance over more than twenty degrees in each direction from the location of the target. Single presentations of the target were made at various contrast values, and the relation between detection accuracy and target contrast was determined. Target contrast was defined by

$$C = \frac{\Delta B}{B} \qquad (1)$$

where ΔB equals the luminance increment added to the prevailing field;
and B equals the luminance of the prevailing field.

The observers were required to prove they could detect the presence of the target by correctly identifying the time interval, of four possible intervals during each presentation, in which the target appeared. Each experiment consisted of 250 presentations of the target. Experiments were conducted at various field luminance values, ranging from 100 to .001 footlamberts. Target size was varied from approximately 1 to 64 minutes of arc in different experiments. The duration of presentation of the target was varied in separate experiments from 1 second to .001 second.

The data were presented in the first paper in a series of graphs, one graph presenting the relation between target contrast and field luminance for each of four target sizes. Alternative scales were presented on each graph representing different levels of accuracy varying from 50 per cent to 99 per cent. The curves fitted through the experimental data were empirical. In this form, the performance data are not easy to use to specify even the quantity of illumination. No indication was given in the earlier paper as to how these data could be used to specify the quality of illumination.

The data presented in the first paper may be generalized to apply to targets darker than the field luminance, by application of results reported

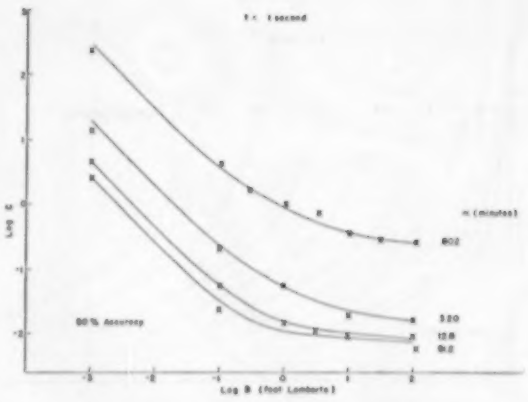

Figure 1. Experimental data obtained in the 1952 study. Each point represents at least 500 responses by two observers.

by the author in 1946.[6] In this paper, it was shown that target contrast may be defined in such a way that targets darker or brighter than the general field are equally detectable at equal contrast. The definition under which this result occurs is as follows:

$$C = \left| \frac{B_T - B_B}{B_B} \right| \qquad (2)$$

where B_T is target luminance and B_B is background luminance.

Other definitions of contrast do not permit use of this simplifying principle. It is to be noted that this definition of contrast is numerically equivalent to the definition presented in equation (1).

Data-Smoothing Procedures

It is a simple matter in principle to utilize the performance data referred to above in specifying the quantity of interior illumination. However, such use of the data involves interpolating between the various data curves presented in the earlier paper. Any such interpolative procedure requires careful data-smoothing, if interpolation is to proceed in an orderly and reproducible fashion. Considerable effort has been expended in recent months in developing smooth empirical functions to describe the experimental data, in order to improve the interpolative process. The curves fitted to the experimental data in recent months differ from the curves fitted to the data in the first paper. In cases of disagreement, curves presented in the present paper are to be used.

It will be well to describe the data-smoothing procedures upon which data presented in this paper are based, in order that the reader will have

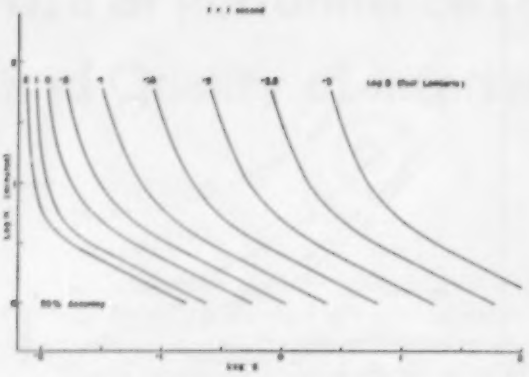

Figure 2. Smoothed-curves based upon theoretical relations between α and C.

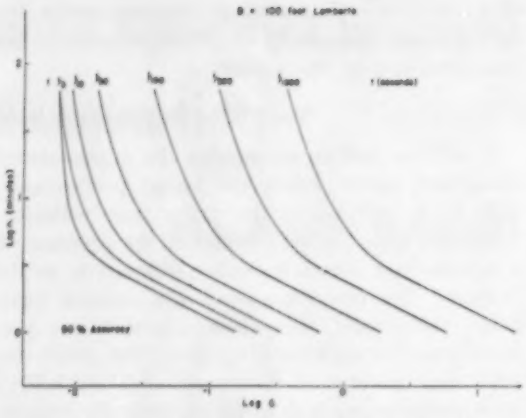

Figure 3. Smoothed-curves based upon theoretical relations between α and C.

confidence in the values reported here. Let us begin by considering the original form of the experimental data, as presented in the first paper. The data for exposure duration of 1 second are presented in this form in Fig. 1. The relations between target contract, C, and field luminance, B, are shown for each of the four target sizes. The data in Fig. 1 represent a fixed accuracy level of 50 per cent, corresponding to what is usually defined as the "threshold." (Note that the angular designations of the targets in Fig. 1 differ from the values presented in the first paper. The present values are correct; the values presented in the first paper were nominal.) It is apparent from Fig. 1 that the data appear to be randomly variable; this implies that there is some latitude possible in fitting the data with smooth curves. The curves drawn through the experimental data in Fig. 1 are the result of the smoothing process, and hence differ from the curves presented in the first paper.

The smoothing process began by plotting curves relating target contrast and target size for each of nine values of field luminance. Such curves are presented in Fig. 2 for the 1-second data previously presented in Fig. 1. Similar curves were plotted for each of the other six target exposure durations. These curves were found to be highly irregular, when they were based upon the empirical curves reported in the first paper.

The smoothing process continued by regularizing families of curves such as the family of curves shown in Fig. 2. Certain restrictions were placed on these curves on the basis of relations between target size and target contrast which have been well established in previous studies of brightness discrimination. For example, for small target sizes, the relation known as Ricco's law must be found. This relation states that $\alpha^2 C = K$. The reciprocal relation between target area and target contrast is absolutely required for targets small with respect to the resolution of the eye. Manifestly, when the retinal image of a target does not change in size with changes in size of the target, changes in area can be compensated for by changes in contrast, in the quantitative manner known as Ricco's law. All we can safely conclude, however, is that Ricco's law represents the limiting relation to be found when target size is small; we cannot be certain below what target size the law must apply. Ricco's law is represented by a linear relation between log α and log C with slope of $-\frac{1}{2}$. This slope has been constructed as the limiting slope of all curves in Fig. 2.

As target size is increased beyond the size where Ricco's law applies, target contrast decreases at a slower rate, but it still decreases as target size increases. As Blackwell and Austin[7] have shown, this relation may be explained as due to a contribution-function concept, where it is assumed that a unit area of the target always contributes to the detectibility of the target, with the amount of contribution being reduced as the unit area is separated farther and farther from the target center. In an approximate sense, contribution-functions represent first derivatives of the curves presented in Fig. 2. The details of this concept need not concern us here. Suffice it is to state that curves such as those shown in Fig. 2 may have the requirements placed on them that contribution-functions derivable from them are monotonic, and that changes in contribution-functions proceed in an orderly manner as B is changed. The smooth curves shown in Fig. 2 were constructed from contribution-functions having such characteristics.

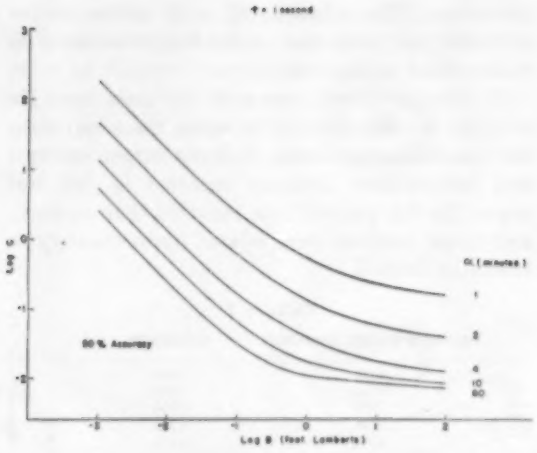

Figure 4. Interpolations from the curves of Fig. 2.

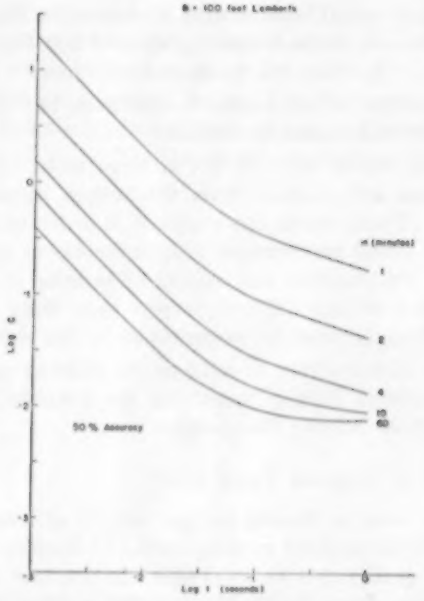

Figure 5. Interpolations from the curves of Fig. 3.

The actual contribution-functions will be reported elsewhere.[8]

Curves such as those shown in Fig. 2 were constructed for each of the six other target durations, utilizing the contribution-function smoothing procedure. Then, the curves were replotted as shown in Fig. 3. Here we have brought together curves relating α and C for each of the seven exposure durations, all for a field luminance of 100 footlamberts. Now, the restriction was placed that the changes in the contribution-functions derivable from these curves occur in an orderly manner as a function of exposure duration, at a fixed value of B. This restriction was added to the earlier restriction that the contribution-functions be monotonic, and that changes in contribution-functions be orderly as a function of B, for a fixed target exposure duration. When these restrictions were simultaneously placed on the data, there remained very little latitude in the determination of the contribution-functions and, hence, in the shapes of the individual curves relating α and C.

The absolute placement of these curves on the scale of C is not fixed by use of the contribution-function concept. This placement must depend upon functional relations in which C is a continuous variable. Accordingly, the next step in the smoothing process involved interpolating two classes of graphs from graphs analogous to Figs. 2 and 3. The first of these interpolated graphs presented the relation between C and B, for fixed values of α. In Fig. 4 such a relation is presented, for exposure duration of 1 second. The values of α selected for use in this graph do not correspond to the values experimentally studied, but correspond rather to values of α believed to be of the most use for our purposes here. Since we have continuous graphs relating α and C, we may of course interpolate any values of α of interest, with equal precision. The second class of interpolation is demonstrated by the curves of Fig. 5. Here we plot the relation between C and exposure duration, t, for the same values of α, all for $B = 100$ footlamberts.

Once the curves relating α and C are fixed in form, changes can be made in curves such as those shown in either Fig. 4 or Fig. 5 only by moving all values of α at a given t and B up or down the log C scale by the same amount. Furthermore, the same values appear on two graphs, one of the class illustrated by Fig. 4 and one of the class illustrated by Fig. 5. We now require that the families of curves such as Fig. 4 *and* the families of curves such as Fig. 5 be monotonic and orderly in appearance. It turns out that there remains almost no uncertainty in the form of the curves analogous to Figs. 4 and 5 when all these requirements are met. Work with the present data along these lines demonstrated that changes of the order of 2 per cent were the maximum allowable changes without an obvious violation of one or another of the previously stated requirements.

This process of data-smoothing was carried to completion, with the following results:

(a) A set of seven graphs analogous to Fig. 4, one for each of the seven exposure durations;

(b) A set of nine graphs analogous to Fig. 5, one for each of the following values of Log B: 2, 1, 0, −.5, −1, −1.5, −2, −2.5, and −3.0; and

(c) A set of seven graphs analogous to Fig. 2, one for each exposure duration.

These curves were plotted at large scale; reproductions are available from the author, upon request. These curves are required in order to construct visual performance graphs for use in specifying the quantity and quality of interior illumination involving different targets than those that have been selected for presentation in this paper.

We may now turn to methods for utilizing visual performance data in specifying the quantity and quality of interior illumination.

CASE I: *Uniform Visual Field*

We wish to develop here a method of relating speed and accuracy to the quantity of illumination, since quality has no relevance for the case of a uniform visual field. The simplest method is to plot speed against illumination quantity, for a target of fixed size and contrast, with accuracy as parameter. Speed is defined as the inverse of the exposure duration for the single presentations made in the experimental sessions. Field luminance, B, is used in place of illumination quantity, since B, rather than illumination, is the basic visual variable.

It is entirely straightforward to construct a relation between speed and luminance for 50 per cent accuracy, from graphs such as those shown in Figs. 4 and 5, provided the target size appears as parameter in Figs. 4 and 5. For example, we may specify a target having $\alpha = 1$ and $C = 1$. We may interpolate first a value of B corresponding to $\alpha = 1$, $C = 1$ from each graph analogous to Fig. 4. We may next interpolate values of time corresponding to fixed values of B for $\alpha = 1$, $C = 1$, from graphs analogous to Fig. 5. If additional points are needed, we may interpolate additional graphs analogous to Fig. 5 from the various graphs analogous to Fig. 4, at appropriate values of B. Then, the value of time corresponding to $\alpha = 1$, $C = 1$ may be read. Values of speed are, of course, easily computed from the values of time obtained in this way. This procedure is slow and tedious, but eventually enough points are obtained to define the relation between speed and B for 50 per cent accuracy, for the target of fixed size and contrast. In Fig. 6, we have presented the relation between speed and B for 50 per cent accuracy, for the target described above. A double-logarithmic plot has been used in presenting the data to insure that all values of speed and B may be read with equal precision. (The notation, $B_v = 0$, refers to the uniformity of luminance of the field, a notation to be described subsequently.)

We may construct curves of the same type for different accuracy levels, by using the experimentally established relations between target contrast and performance accuracy reported in the first paper. In this paper it was reported that accuracy and target contrast were related approximately as shown in Table I.

TABLE I.

Relative Target Contrast	Accuracy
1.00	50%
1.26	75%
1.50	90%
1.64	95%
1.91	99%

We may utilize graphs such as those shown in Figs. 4 and 5, representing 50 per cent accuracy, to determine values at higher values of accuracy. We *reduce* the target contrast by dividing target contrast by the appropriate value from Table I before entering it on the graph. For example, we use a contrast of 0.52 when considering a 99 per cent accuracy level for a target of contrast equal to 1 ($0.52 = 1/1.91$). Using *effective contrast* values computed in this way we may determine the relations between speed and B for the target with $\alpha = 1$, $C = 1$, for the four other levels of accuracy of interest. Data obtained in this way are presented in Fig. 6.

There is one minor complication which has not been mentioned. The relation between relative target contrast and accuracy is only approximately constant for the various values of B, α, and t. As reported in the first paper, this relation varies insignificantly as a function of α or B, but it varies significantly as a function of t. This variation is indicated by the values presented in Table II.

TABLE II.
(Values of Relative Target Contrast)

Time (Seconds)	Accuracy 50%	75%	90%	95%	99%
1	1.00	1.33	1.63	1.80	2.13
1/3	1.00	1.30	1.58	1.74	2.05
1/10	1.00	1.25	1.48	1.62	1.87
1/30	1.00	1.25	1.48	1.61	1.86
1/100	1.00	1.24	1.47	1.60	1.84
1/300	1.00	1.24	1.47	1.60	1.84
1/1000	1.00	1.22	1.43	1.55	1.77

In determining the curves for higher accuracies in Fig. 6, these variations as a function of exposure duration were taken into account. When interpolating from graphs analogous to Fig. 4, the value of effective contrast was determined by dividing target contrast by the value in Table II. Direct entry was made into the graphs analogous to Fig. 4.

When interpolating from graphs analogous to Fig. 5, a reiterative solution was required, since the value of effective contrast depends upon the value of time. An approximate value of effective contrast was used, and a value of time read. Then, a corrected value of effective contrast was computed, and a new value of time read. This process was continued until insignificant changes in the value of t were obtained on successive readings.

Data are presented in Figs. 7-11 for targets varying in α from 1 to 4 minutes of arc, and in contrast from .2 to 1. The six targets studied are consid-

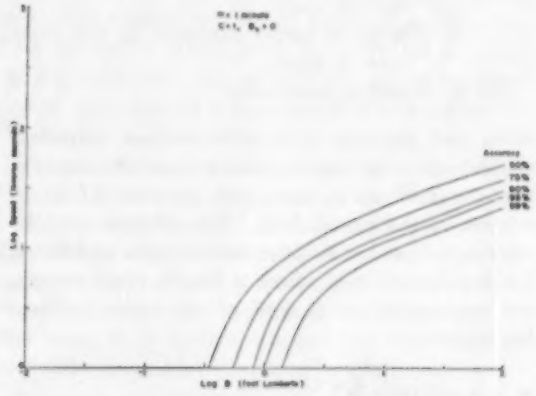

Figure 6. Interpolated visual performance curves for $\alpha = 1$ minute, contrast = 1.

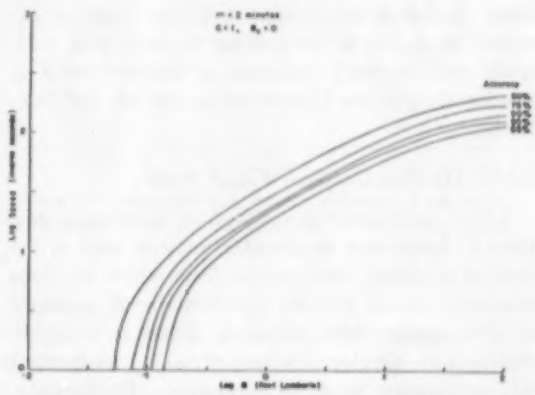

Figure 7. Interpolated visual performance curves for $\alpha = 2$ minutes, contrast = 1.

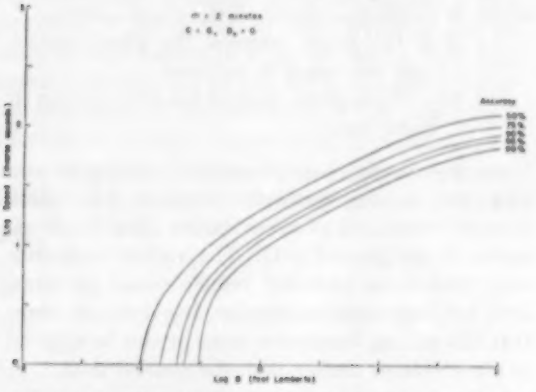

Figure 8. Interpolated visual performance curves for $\alpha = 2$ minutes, contrast = .6.

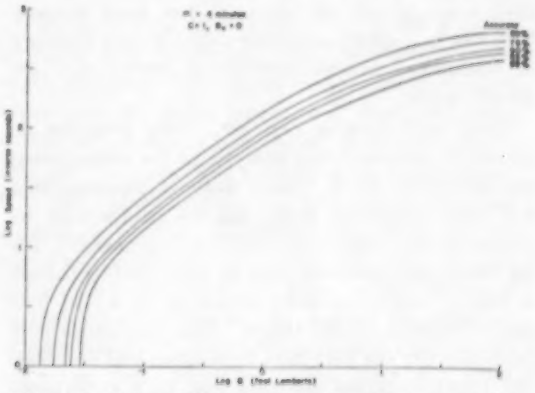

Figure 9. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast = 1.

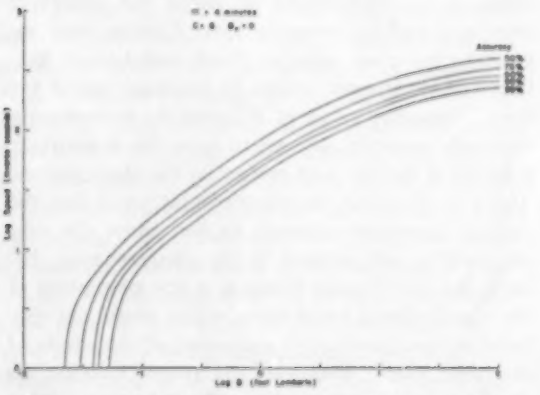

Figure 10. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast = .6.

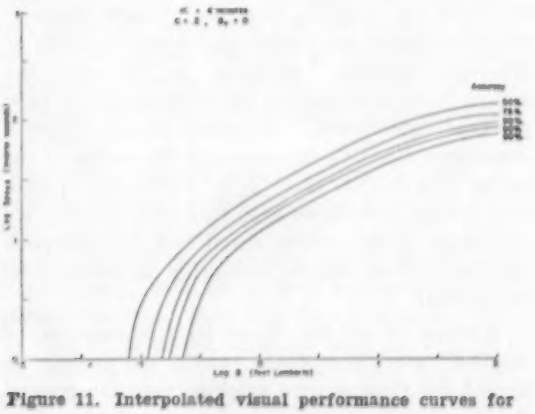

Figure 11. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast = .2.

ered reasonably typical of visual tasks of practical interest which are similar to the task required of the experimental observers.

It is obviously a simple matter to relate speed and accuracy to the quantity of illumination from the graphs presented in Figs. 6-11. For any given target, we can determine the speed improvement (for constant accuracy), or the accuracy improvement (for contrast speed), resulting from an increase in B. It is interesting to note that both speed and accuracy continue to increase as B is increased up to the highest value studied, 100 foot-lamberts.

CASE II: *Non-Uniform Visual Field*

Visual environments are seldom, if ever, as uniform in luminance as the environment used in the studies of visual performance from which the data employed above for the specification of quantity of illumination were obtained. Thus, it is highly desirable to develop a means of taking account of non-uniformity in field luminance. Fortunately, extensive studies have been conducted in which the effect of non-uniformity of luminance of the visual field upon visual performance has been studied. The loss in performance occasioned by the presence of luminance non-uniformities is known as "disability glare."

Moon and Spencer *(op. cit.)* have provided an excellent summary and analysis of the experiments on disability glare. These authors have pointed out that disability glare can be understood by means of the concept of "veiling luminance." The effects of glare sources may be described as though a veiling luminance were added to the visual field in the vicinity of the target. This luminance both increases the effective field luminance and decreases the effective target contrast just as a superposed real luminance would do.

The veiling luminance concept has validity, in the author's opinion, only for "glare sources" which represent luminance increments to a field of otherwise uniform luminance. In this case, the veiling luminance concept has been shown[9] to have physical significance. The glare sources *literally* contribute a veiling luminance to the center of the visual field due to "stray light" within the eyeball. This veiling luminance both increases the effective luminance of the central visual field and decreases the contrast of targets appearing in the central visual field.

Whether or not the "stray light explanation of disability glare is accepted (and it can scarcely be denied for glare sources brighter than the general field), all authors agree on the quantitative characteristics of the effects of disability glare. These relations may be written as follows:

$$B_e = B + B_v \tag{3}$$

$$C_e = C \cdot \frac{B}{B_e} \tag{4}$$

where B_e = effective field luminance in the presence of glare;
C_e = effective target contrast in the presence of glare;
and B_v = veiling luminance.

Moon and Spencer have presented an empirical method of computing B_v from information concerning the luminance, size, and position of glare sources in the visual field. This relation may be rewritten in ordinary photometric units as follows, for the special case where n bright glare sources are superposed on a field of otherwise uniform luminance:

$$B_v = \frac{9.6 \times 10^{-3}}{\pi} \sum_{i=1}^{n} \frac{G_i \cos \theta_i}{\theta_i^2}\, \omega_i$$

where G is the luminance of the glare sources;
θ is the angle between the glare sources and the target in radians;
and ω is the angular area of the glare source in steradians.

Moon and Spencer are apparently willing to employ the veiling luminance concept for "glare sources" consisting of areas darker than the luminance of the general field. The author recognizes that dark areas probably reduce visual performance for one reason or another, but does not agree that the veiling luminance concept can be applied to glare sources darker than the general field.

It should also be pointed out that the data upon which the veiling luminance concept is based were obtained in experiments in which the observers were required to maintain their fixation with respect to the glare sources. Such stability of fixation seldom, if ever, occurs in practical use of the eyes. Thus, the value of B_v must be a constantly changing quantity, dependent upon the momentary position of the eye with respect to the glare sources. There is, of course, no experimental proof that the veiling luminance concept applies when the eyes are moving with respect to the glare sources. Effects due to transient changes in the adaptation of the visual system could occur which would not conform to the quantitative statement of the effects of disability glare. However, the author believes the disability glare concept has sufficient value so that it may be used as an approximation in describing

the effects of bright glare sources upon visual performance.

We may now describe a method for evaluating the effects of non-uniformity of field luminance upon visual performance, utilizing the veiling luminance concept. Since every visual field possesses a unique collection of glare sources, it will be desirable to develop a general method readily applicable to any particular pattern of field non-uniformity. This method is based upon the effect of a given veiling luminance, B_v, without regard to the particular collection of glare sources which produced the disability glare effect.

The method may be illustrated by reference to Fig. 12. Here we have presented the relation between C and B for $x = 1$ minute, and $t = 1$ second. The curve represents the relation between C and B for a field of uniform luminance. This curve is a reproduction of the uppermost curve in Fig. 4. The label, $B_v = 0$, refers to the fact that there is no veiling luminance produced by glare sources.

We want to construct a curve representing the relation between C and B in the presence of a veiling luminance produced by glare sources. This procedure is simplified by considering B_v to be constant with respect to B, for all values of B. The physical significance of this relation would be that the luminance of all elements of the visual field increase or decrease proportionally together.

For simplicity, consider first the case where B_v is assumed to equal B. Then, from equations (3) and (4):

$$B_e = 2\,B$$
$$\text{Log}\,B_e = \text{Log}\,B + .30 \qquad (6)$$

$$C_e = .50\,C$$
$$\text{Log}\,C_e = \text{Log}\,C - .30 \qquad (7)$$

We may use the relations given in Equations (6) and (7) to construct a visual performance curve relating C and B in the presence of disability glare. Consider the point on the curve in Fig. 12 labeled A. This represents a value of field luminance of 1 footlambert. The value of C, equal to .56, represents the target contrast required for 50 per cent accuracy of detection for 1-second exposure duration. Now, the presence of disability glare increases the effective value of field luminance from B to B_e. If this increase in the effective field luminance were the only effect of disability glare, there would obviously be an improvement in visual performance, since it is clear from Fig. 12 that the contrast required for detection decreases continuously as B increases. Our method proceeds by

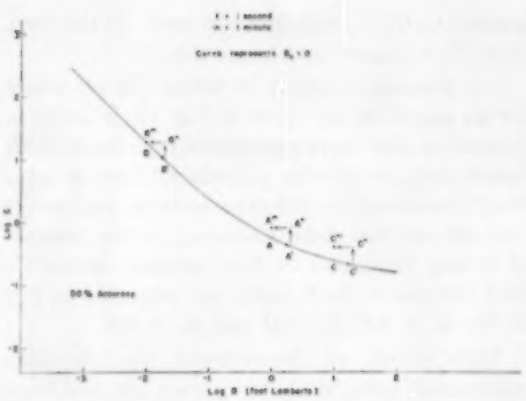

Figure 12. Demonstration of the calculation of visual performance data in the presence of disability glare.

moving down the curve in Fig. 12 to the point A'. At the point A', we have field luminance equal to B_e. The location of point A' signifies that the required target contrast has decreased from .56 to .42 as field luminance has increased from B to B_e.

Unfortunately, however, disability glare not only increases field luminance, but it also decreases target contrast. This means that we must increase target contrast in the presence of disability glare so that, when reduced by glare, there will remain sufficient contrast. We proceed next to the point A''. This point represents the target contrast required to produce the value of contrast, C_e, required at the effective luminance, B_e. Now, finally, we proceed to the point A'''. Here we have referred the real contrast required to produce the effective contrast (required at the effective field luminance) to the real field luminance value. Thus, the point A''' is to be compared directly with the point A to evaluate the net effect of a veiling luminance, B_e equal to B, where in this example $B = 1$ footlambert. Since A''' represents a larger contrast value than A, this means that the net effect of veiling luminance was to increase the target contrast required for fixed accuracy at a fixed target exposure duration.

An entirely similar procedure was followed at two other values of field luminance. First, the procedure was followed at field luminance of .01 footlambert. In this case, the symbols B, B', B'' and B''' were used, with the primes having meanings analogous to those used with the A symbols. We note that B''' is almost identical with B. This implies that the net effect of disability glare was very small. Finally, the procedure was followed at field luminance of 10 footlamberts. In this case, the

symbols C, C', C'', and C''' were used. In this case, then, C''' is a great deal larger than C.

It is possible, of course, to follow this procedure for all points on the curve in Fig. 12, in order to generate a new curve representing the locus of all values obtained by this procedure. Such a curve would represent the relations between real target contrast and real field luminance, in the presence of veiling luminance of fixed amount relative to field luminance. Such curves are presented in Fig. 13 for $B_v = .5B$, $B_v = B$, and $B_v = 2B$.

These curves all demonstrate one interesting relationship between disability glare and field luminance. The increase in required target contrast, due to the deleterious effect of disability glare, is increasingly large as field luminance is increased, when B_v is fixed with respect to B. This means that in a given lighting installation, as the luminance of every element is increased proportionally, the effect of disability glare is increased. To the best knowledge of the author, this relationship has never been studied experimentally. This relation confirms the wide-spread opinion that uniformity of field luminance is increasingly important, the higher the value of B.

It should be pointed out that the values of B_v plotted in Fig. 13 are quite large. There are few modern lighting installations in which B_v is as great as $2B$. However, values of B_v as large as $.5B$ are often obtained, and values of B_v as large as B are sometimes obtained.

A concrete example of the values of B_v relative to B may be in order, since disability glare is not usually described in this manner. A lighting installation was assumed in which the luminance in the vicinity of the target was 10 footlamberts. Fluorescent fixtures were considered to be located at a mean distance of 10 degrees above the line of sight. The fixtures were taken to have an average luminance of 1500 footlamberts. The angular dimensions were assumed to be 4 by 28 degrees. Using Equation (5), B_v was computed to be 5.0 footlamberts. Obviously, this example represents the case where $B_v = .5B$ (as indeed it was selected to). It is recommended that the illuminating engineer compute values of B_v relative to B in various real lighting installations in order to obtain a conception of the meaning of various values of B_v relative to B.

Once we have curves relating C and B for a given B_v/B ratio, we can proceed to evaluate the effect of the quantity of non-uniform field luminance upon the speed and accuracy of visual performance. Curves analogous to those of Fig. 5 can

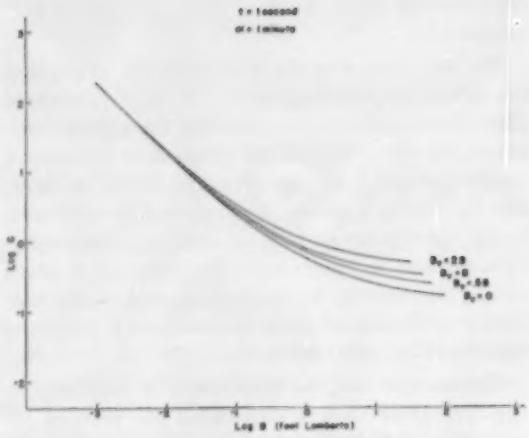

Figure 13. Interpolated curves representing various degrees of disability glare.

be constructed for different values of α and different B_v/B ratios. Then, interpolations can be made, as before, to relate speed and B for each of several accuracy levels. (If other values of α are of interest, curves analogous to those in Fig. 4 are first interpolated from curves analogous to Fig. 2. Then B_v curves are constructed as in Fig. 12.)

Curves relating speed and accuracy to the quantity of non-uniform-field luminance have been constructed for the case where $B_v = .5B$, for targets varying in α from 1 to 4, and varying in contrast from .2 to 1. The results are presented in Figs. 14-19, representing the same values of target size and contrast presented in Figs. 6-11. It is apparent that, as before, speed and accuracy continue to increase with increase in the quantity of illumination up to the highest value which can be studied.

Comparative Evaluation of Quantity and Quality

One of the most important problems related to the specification of illumination concerns our perpetual inability to evaluate the relative significance of quantity and quality of illumination. It is generally agreed that: (a) with "adequate quality," the higher the level of illumination, the better the visual performance; and (b) poor quality of illumination will reduce visual performance at any level of illumination. Unfortunately, in most lighting installations, quantity and quality of illumination are interrelated. For example, it is often necessary to introduce high luminance sources into the visual field (poor quality) in order to obtain high levels of illumination (good quantity). We

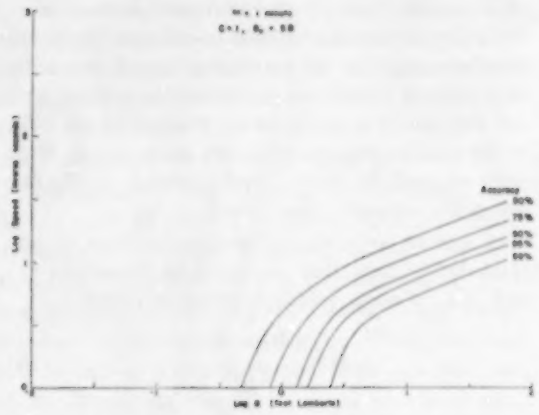

Figure 14. Interpolated visual performance curves for $\alpha = 1$ minute, contrast $= 1$.

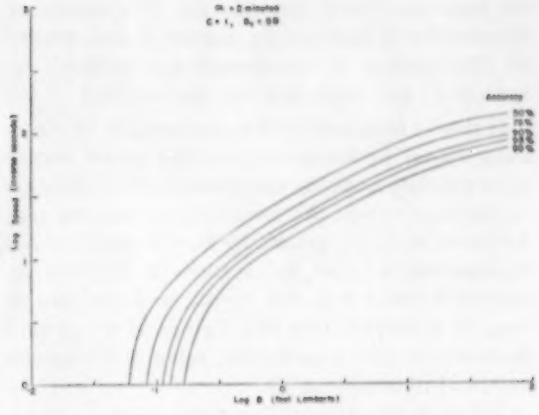

Figure 15. Interpolated visual performance curves for $\alpha = 2$ minutes, contrast $= 1$.

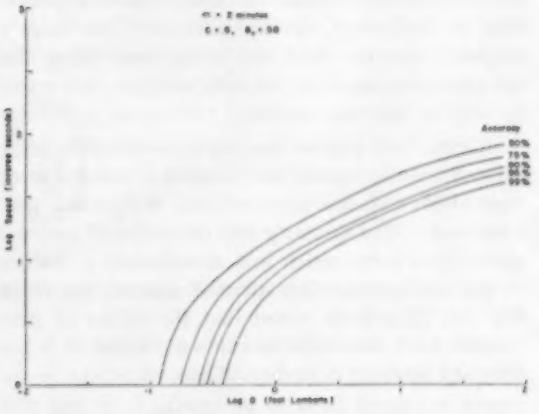

Figure 16. Interpolated visual performance curves for $\alpha = 2$ minutes, contrast $= .6$.

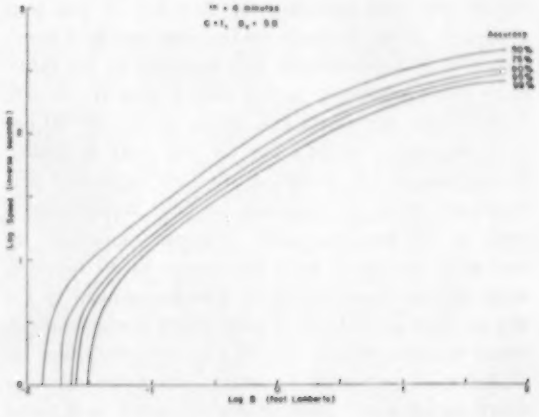

Figure 17. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast $= 1$.

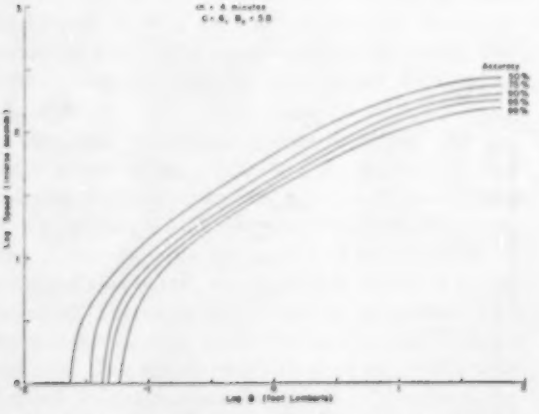

Figure 18. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast $= .6$.

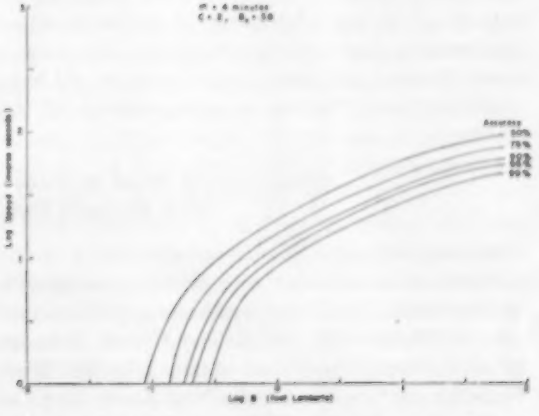

Figure 19. Interpolated visual performance curves for $\alpha = 4$ minutes, contrast $= .2$.

are thus faced with the question: If quantity of illumination is increased by amount X, and quality of illumination is correspondingly reduced by amount Y, will there be a net gain or loss?

It should be apparent that the methods of evaluating visual performance described above permit us to evaluate quantity and quality of illumination in the same terms. We have only to compare performance in paired graphs for $B_v = 0$ and $B_v = .5B$ to ascertain whether an increase in B which increases B_v from 0 to $.5B$ results in a net gain or loss. It is believed that this feature of the present method will have considerable value in the specification of illumination.

An example of this use of the graphs will be appropriate here. Consider a target with $\alpha = 1$ minute and $C = 1$. Suppose we can obtain uniform field luminance only as great as 10 footlamberts. At this field luminance level, speed is given as 8.9 for 99 per cent accuracy, or 22.4 for 50 per cent accuracy. Now, suppose we increase the field luminance to 60 footlamberts, but in doing so, we introduce non-uniformity to the extent that $B_v = .5B$. Under these circumstances, speed is 10.5 for 99 per cent accuracy, or 30.2 for 50 per cent accuracy. Regardless of our criterion, we have improved performance with the increase in field luminance *in spite* of the loss in quality. Suppose, however, we had only increased field luminance to 30 footlamberts before non-uniformity was introduced to the extent that $B_v = .5B$. Under these circumstances, speed is given as 8.0 for 99 per cent accuracy, or 22.9 for 50 per cent accuracy. Here we consider there to be a net gain *if* higher speed and lower accuracy are required, or a net loss *if* lower speed and higher accuracy are required.

It might be remarked that it is just this kind of difference in conclusion, depending upon the importance of speed and accuracy as performance criteria, which has always led the author to advocate treating these criteria separately. An analysis in which speed and accuracy are pooled would have concealed this difference in interpretation of the results.

Comparison of These Methods With Weston's Data

It seems desirable to compare the results of the methods developed here with illumination specifications based upon the well-known performance data of Weston *(op. cit.)*. The Weston data selected for comparison were obtained in the "First Investigation" reported in the 1945 paper. In these experiments, the observers cancelled breaks in Landolt broken rings, which appeared as dark targets on a brighter field. Both speed and accuracy were studied as a function of field luminance. Performance was rated as the product of speed and accuracy indices. Data are available for targets with $\sigma = 1$, 3, and 6 minutes, where these measures refer to the angular size of the breaks in the rings. Data were selected for $\alpha = 1$ and contrast = .91, this being the contrast value closest to 1.

It is to be noted that Weston's definition of contrast differs from that presented in Equations (1) and (2). Weston defines contrast as follows:

$$C = \frac{|B_G - B_L|}{B_G} \qquad (8)$$

where B_G is the luminance of target or field, whichever is greater;

and B_L is the luminance of target or field, whichever is less.

For targets darker than the field, Weston's definition is equivalent to the author's; for targets brighter than the field, the definitions differ. In the present case, then, we may compare contrasts directly in the two studies.

In order to render our data comparable with Weston's data, speed and accuracy values were multiplied and the product was designated *performance*. (The quantity has the units of inverse-seconds-per cent, which is a monstrosity.) Values of log performance are plotted against log B in Fig. 20. It is to be noted that the values of performance are not equal at the same value of B for different levels of accuracy. There is, of course, no reason to expect them to be equal. It is just this lack of precise meaning of the product of speed and accuracy indices which makes the joint index undesirable. For comparison, Weston's raw per-

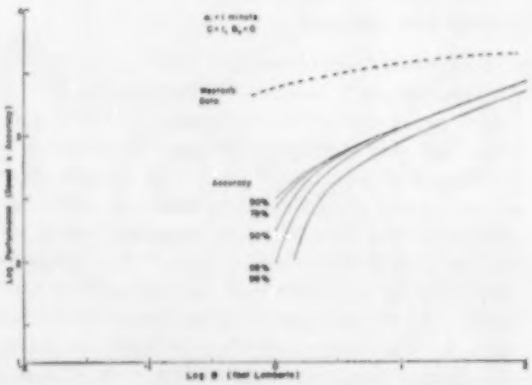

Figure 20. Comparison of performance data from the present paper with Weston's performance data.

formance data are plotted in Fig. 20. Values of B were computed from Weston's illumination data, and the recorded reflectance of the paper which served as target background. Weston's values of performance have been multiplied by 10,000 to bring them to a convenient position on the graph.

It is apparent that Weston's performance data do not show as great a variation with field luminance as do our data, expressed in terms of performance. This difference is believed due to time loss involved in scanning the Landolt rings which occurred in Weston's experiment. This time loss may be expected to change very little as a function of B. Thus, the change in speed of visual performance in the static situation of our experiments as a function of B is masked in Weston's data by a large fixed time-loss, common to all values of B. The "action time" determination Weston used to eliminate the time required for motor performance of the task does not eliminate the effect of time lost in search, because the red rings used in the action-time determination did not have to be scanned to see if they contained breaks.

It is important to understand the basis of differences between various methods used to specify illumination so that the most appropriate method may always be employed. Weston's data do apparently include a scan-time factor, the relevance of which will vary with applications to be made of the data.

Comparison of These Methods with the Delos Method of Moon and Spencer

It may surprise the reader to learn how simply the present methods may be compared with the Delos method proposed by Moon and Spencer for the specification of illumination. Here we will free the Delos method from the analytical form and special terminology in which it is usually phrased, and reveal it as a very simple concept which appears to have little or no relation to visual performance as the term is used by the illuminating engineer.

Consider the graphs presented in Fig. 21. The solid curve is the plot, by now familiar, of the relation between C and B for $t = 1$ minute and $t = 1$ second, for 50 per cent accuracy. Now, the Delos concept may be explained very simply in terms of this curve. At the larger values of B, the value of C tends to reach a lower asymptote. This asymptote has been indicated by the solid horizontal line. The extent to which C at any value of B *exceeds* this asymptotic value of C is considered by Moon and Spencer to be a reduction in visual "performance." Delos is defined in this case as the

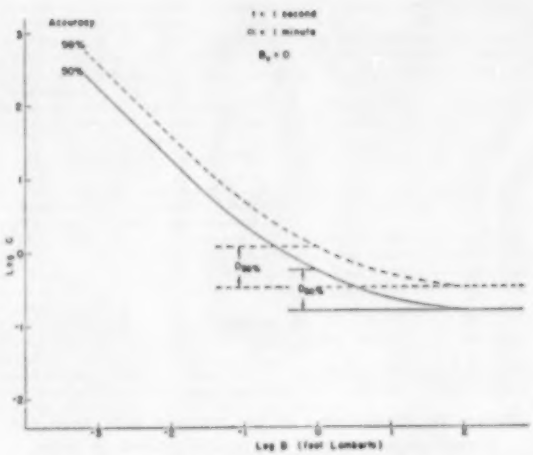

Figure 21. Comparison of performance data from the present paper with D, a quantity related to Delos.

asypmtotic value of C divided by the value of C at any value of B of interest.

We may define a quantity, D, which bears a simple relation to Delos. This quantity is merely the value of log C at a value of B of interest minus the asymptotic value of log C. Obviously Delos = 1/antilog D. The quantity D is convenient to use in relating our method to the Delos method; this quantity can be converted into values of Delos, if desired. In Fig. 21, D is specified for B equal to 1 footlambert. From this value of D we may compute Delos, which is intended to measure the effectiveness of visual performance at B equal to 1 footlambert.

Fig. 21 contains, in addition to the curve for 50 per cent accuracy, a curve relating C and B for 99 per cent accuracy. Since as indicated above, the relation between the two accuracy levels is constant for all values of B, the curves are identical in form, being merely displaced on the scale of log C with respect to each other. Note the dashed horizontal line indicating the asymptotic value of log C for the 99 per cent accuracy curve. The value of D is specified at $B = 1$ footlambert as before. As before, the value of D is intended to evaluate visual performance at $B = 1$ footlambert.

It is shown in Fig. 21 that the values of D are identical for the curves representing the two levels of accuracy. This identity depends on the fact that the two curves are parallel. This implies that the values of Delos are identical. This identity of the value of Delos points to the irrelevance of this index to visual performance. Here we conclude that the Delos for $B = 1$ footlambert is the same whether performance accuracy is 50 or 99 per cent.

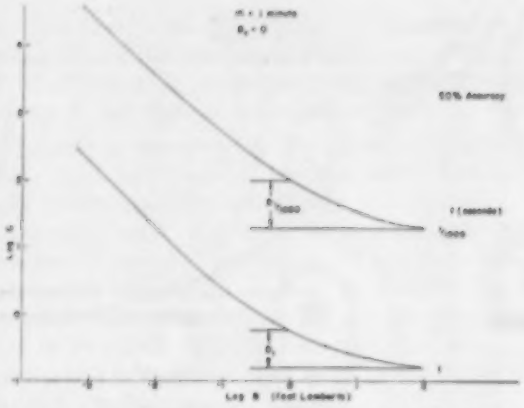

Figure 22. Comparison of performance data from the present paper with D, a quantity related to Delos.

Fig. 22 is presented to show the relation between Delos and speed of performance. The lower curve in Fig. 22 is the curve for 50 per cent accuracy presented in Fig. 21. The value of D at $B = 1$ foot-lambert here is, of course, the same as it was for 50 per cent accuracy in Fig. 21. The upper curve in Fig. 22 represents exposure duration of 1/1000 second. Here D is again specified at $B = 1$ foot-lambert. The two curves in Fig. 22 are *not* parallel, hence the two values of D are not equivalent. Values of Delos are .28 for $t = 1$ second, and .19 for $t = 1/1000$ second. Now, even though Delos does vary as a function of target exposure the variation is very small when we consider that what we have called speed varied by one thousand to one.

It should be apparent from examination of Figs. 21 and 22 that Delos bears a very indirect relation to the usual criteria of visual performance, speed and accuracy. For this reason it is the author's opinion that Delos has little relevance to the specification of illumination in terms of visual performance.

Delos really refers to visual "performance" in an entirely theoretical sense. Either photochemical or neural theories of vision assumes that at high values of B all foveal receptive units are being used to their fullest capacity. This "maximum performance" is revealed by the fact that the smallest possible visual angles and contrasts can be discriminated at high values of B. At lower values of B, the receptive units are used at less than their maximum capacity. This loss in "performance" is revealed by the larger angles and contrasts which are required for discrimination at lower values of B. It apparently seems reasonable to Moon and Spencer to rate visual "performance" by the maximum angle or contrast divided by the obtained angle or contrast; their concept must come from the notion of "performance" described here. However, it is the author's contention that this conception of "performance" has only theoretical significance and has no direct relevance to performance as the term is used by illuminating engineers.

One final relation between our methods and the Delos method needs to be demonstrated. Thus far, we have considered the Delos method only as applied to fields of uniform luminance. When the Delos method is applied to the case of non-uniform fields, the following approximate relation is given by Moon and Spencer:

$$\text{Delos (non-uniform)} \cong \text{Delos (uniform)} \times \frac{B}{B_e} \tag{9}$$

Figure 23 has been constructed to illustrate the relations between Delos for the cases of uniform and non-uniform field luminance. The lower curve is the familiar curve relating C and B for $\alpha = 1$ minute, $t = 1$ second, and 50 per cent accuracy for B_e = zero. The upper curve is the curve for $B_e = .5B$, constructed as demonstrated in Fig. 12.

Delos is to be evaluated in terms of the asymptotic value of C obtained with a uniform field luminance, whether the field luminance is uniform or non-uniform. Thus, values of D are specified as shown in Fig. 23; where D_u refers to the case of uniform field luminance; D_{nu} refers to the case of a non-uniform field.

Computation reveals values of Delos equal to .28 for the uniform and .23 for the non-uniform case in Fig. 23. From Equation (9), we predict a value

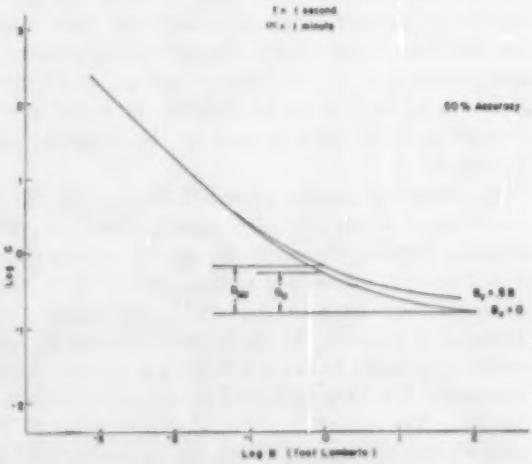

Figure 23. Comparison of performance data from the present paper with D, a quantity related to Delos.

of Delos equal to .19 for the non-uniform case. This may seem like fair agreement. Actually, it should be apparent from our construction in Fig. 12 that Equation (9) is not adequate. The ratio B/B_e defines the extent of movement from A to A', from A' to A'', and from A'' to A'''. The Delos relation in Equation (9) is obviously correct only if C is not varying appreciably with respect to B. Then, and only then, will the move from A to A''' equal the moves from A to A', A' to A'', and A'' to A'''.

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Graduated Levels for an "Open-Type" Bank

The previous lighting at the First National Bank of Joplin, Missouri, had been from continuous rows of louvered luminaires. Benjamin Weintraub, Electrical Engineer with Bank Building and Equipment Corp. of America, St. Louis, in relighting the bank wished to remove the "supermarket" look and restore a dignified bank atmosphere.

In the public lobby, 8 ft by 8 ft specially-designed cavities, with metal louvers, each contain eight 48-inch fluorescent strip lights. At the tellers' stations, lighting is from a combination of 150-watt R-40 flood lamps, recessed over each side of each teller's deal plate, and a continuous row of recessed troffers with Alba-Lite diffusers using three 48-inch fluorescent lamps.

Since the tellers' work areas are of the open type, it was decided not to have a sharp division of lighting levels, but a gradual increase, with emphasis on the teller locations. Maintained illumination after eight months in service was: In center of lobby (between fixtures), 28 ft-c; in front of teller stations, 38 ft-c; at tellers' work stations, 55 ft-c.

Photo: Bank Building and Equipment Corp.

MOVIE LIGHTING — Complete lighting equipment for shooting in color is a frequent assignment for specialized mobile lighting. Equipment includes great cranes, telescoping motor-driven hoists weighing tons, portable 600-ampere d-c generators and transformers, and lights in great variety of size and type.

Specialty Lighting—Anytime, Anywhere

FLOWER SHOWS — Quite another lighting effect is required for this type of display. In common with other installations, however, is the wide range of equipment required, all of which may have to be hauled hundreds of miles, quickly and safely.

DISASTER AREAS — Following the disastrous fire of General Motors Hydramatic Transmission Plant last year, salvage operations went on the clock around, for fourteen days and nights. Illumination of the dangerous wreckage was an assignment for "specialized lighting" with tons of mobile lighting equipment.

During the last decade particularly, there has developed a growing demand for specialized illumination of temporary events—displays, motor shows, sports. This interesting phase of lighting application has created a new industry within the lighting field, calling for a special type of expert and, usually, mobile equipment. Installations may be for a wide range of purposes — from lighting of disaster areas to private parties or gigantic shows. Examples of some such assignments are shown here, courtesy of Jack Frost Company, Detroit, nationally-known specialists in this field.

AUTO SHOWS — Enhancing the appeal of products display, specialized lighting has become a major factor in modern merchandising. Here, an inverted umbrella design of luminous glass panels and highlight spots, dimmer controlled, provide maximum appeal for this 1955 DeSoto car. Other displays used ceiling panels, wall panels and circular, dome-hidden lighting effects. Installations of this kind frequently must go beyond the available sources of power supply, and may require thousands of man-hours to assemble. Power supplied for the motor shows exceeded 2560 amperes at 110 volts.

The Mercury Vapor Lamp As a Circuit Component

By DR. HERBERT O. ROST

THE MERCURY VAPOR LAMP is one of the most peculiar components an electric circuit may contain. Not only is its characteristic dependent upon factors inherent in the lamp and its ambient conditions, but it varies also as a function of its circuit conditions.

As a component of an electric circuit, no property whatsoever contributes to the description or understanding of the mercury vapor lamp that can not be expressed in ohms and seconds. These values are derivable from the schematic characteristic of the mercury vapor lamp as shown in Fig. 1. There are actually five different phases with five different characteristics:

(1) The igniting of the arc (from zero to $E_{v.c.}$ to Point I).

(2) The stabilization period, comprising 90 to about 120 cycles, where the lamp current and arc voltage follow the curves, denoted by a, until a certain stabilization is attained at point S.

(3) The starting period (from point S to point O, the operating point at rated current).

(4) The operating phase (close to point O), when the lamp is under normal operation at rated current.

(5) The extinguishing period (from point O to point E).

The branch O-S' shows the static characteristic of the lamp when operated at currents up to the short circuit current of the lamp ballast. This is the only branch where the resistance of the lamp reaches positive values.

During any other phase, no matter whether it is dynamic or static, the most noticeable feature of the mercury vapor lamp is its negative resistance:

$$R_n = -\frac{dE}{dI}$$

More than in other gaseous discharge lamps such as luminescent, fluorescent, or cold cathode tubes, this negative resistance is a function of the operating conditions. On the other hand, gaseous discharge lamps share this property of the negative resistance, the "falling characteristic" with some other devices, mainly the vacuum tubes. However, there are a few very distinctive and discriminating factors to be noticed:

The determining factor in an electronic tube is the voltage, while the variation in the voltage of an arc is caused by the variations of its current.

Both devices are oscillators: in vacuum tubes, oscillations are excited when the negative resistance (R_n) becomes smaller than the positive resistance (R_p) of the circuit, whereas in an arc, the condition of self-excitation of oscillations is defined by a negative resistance (R_n) being greater than the positive circuit resistance (R_p).

The mean negative resistance of an electronic tube passes the ∞ value, that of an arc passes the zero value. Therefore, the condition of arc stability is given by:

$$\frac{d^2E}{dI^2} = 0$$

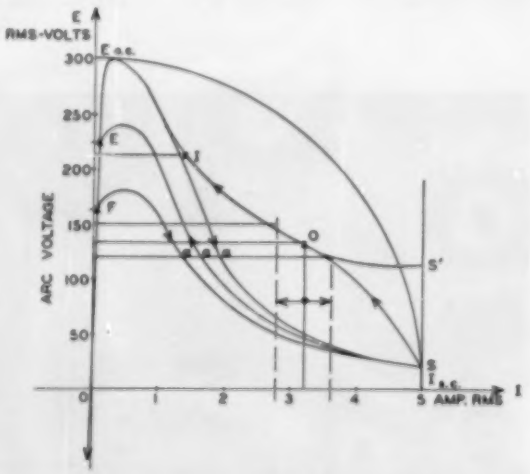


Figure 1. Mercury vapor lamp characteristics.

F — Flickering point
I — Igniting point
S — Point of minimum arc voltage
O — Operating point, normal
S — Operating point at short circuit current
E — Extinguishing point.

AUTHOR: Chief Development Engineer, Jefferson Electric Co., Bellwood, Ill.

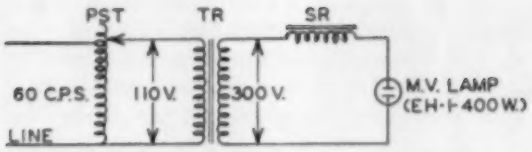


Figure 2. Testing circuit for mercury vapor lamp operated over standard reactor (S R).
T R — Step-up transformer to separate d-c current from a-c circuit.
P ST — Powerstat.

This is the reason why oscillating circuits using electronic tubes are built as parallel resonant circuits and those using arcs by means of series resonant combinations.

The time factor is negligible in electronic tubes, while it is rather crucial in circuits with arc tubes.

The instability of the negative resistance enables both kinds of tubes to convert a-c into d-c. This property is widely being used in rectifiers, but is considered very undesirable in discharge lamps. This trait causes a great many troubles to the designer of lamps or ballasts as well as to the maintenance man in the field.

Of all phases and conditions of performance undoubtedly the heaviest is the rather dynamic period of arc stabilization. All the other stages of performance are well covered in literature but there is almost no understanding, knowledge, and agreement upon the stabilization act. Sometimes when an installation with mercury vapor lamps causes trouble, the lamp manufacturer feels the fault lies with the ballast manufacturer, while the latter claims that his ballasts ensure best performance of properly designed lamps. The lamp manufacturer feels the high inrush current is responsible for lamp failures, while the ballast manufacturers argue that the high inrush current is caused by too high a rectification rate of the lamp. Both usually agree that the direct current as produced during the arc stabilization saturates the core of the ballast and results in high inrush. This explanation is as widely agreed upon as it is unsatisfactory.

There is still another misinterpretation of a very important occurrence in connection with the stabilization of the arc. This is the fact that during this period, the lamp current is offset against the zero line. The interpretation of this fact can only be that direct current is flowing through the lamp and its circuit. Conclusion: the lamp operates as a rectifier. This judgment deserves some consideration.

A somewhat symmetrical lamp when operated over a somewhat symmetrical ballast rectifies either way. This means the rectification occurs in both half-cycles. In the ideal case, the resultant of this rectification would be zero. Tests performed in a circuit as shown in Fig. 2 show a bilateral rectification over longer periods of the stabilization phase. As the conditions are not fulfilled in an ideal way, the resultant d-c is the sum of the two half-wave direct currents, which are slightly different in size.

The above-mentioned circuit can be considered as a standard circuit provided that the reactor and step-up transformer values are agreed upon values. The tests performed with a standard reactor and a reference lamp (135 volts are voltage at 3.2-ampere lamp current) delivered the following results:

(1) The stabilization period lasts about 60 cycles. After that the arc voltage drops to its minimum value of about 15 volts.

(2) In most of the cases, the rectification is unilateral; this means a distinctive decision in favor of one polarity is noticeable (Fig. 3).

(3) The direct current is rather constant. Its value is slightly below the crest value of the alternating current. (Fig. 3.)

(4) The voltage across the choke is constant throughout the entire stabilization period. Its wave shape is distorted, as can be seen from Fig. 3.

(5) The bilateral rectification and its effect on the symmetry of the lamp current is shown in the oscillogram (Fig. 4).

These test results justify setting up the following theory:

During the stabilization phase, the mercury va-

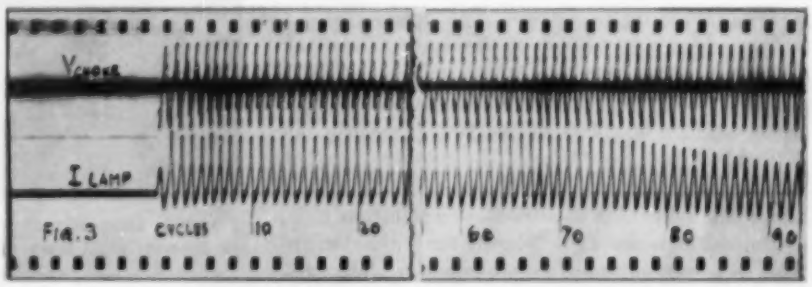


Figure 3. Lamp current (I_{LAMP}) and voltage across choke (V_{CHOKE}) of 400-watt E-H1 lamp, started over standard reactor.

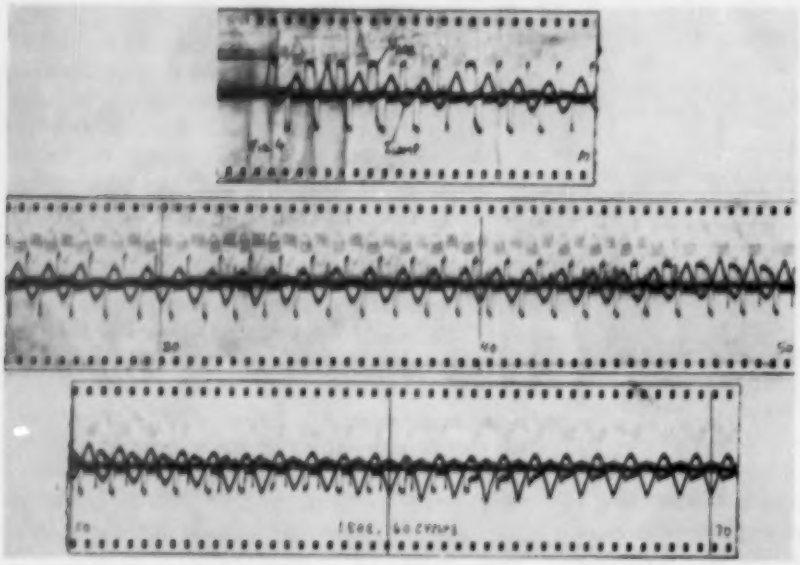


Figure 4. Arc voltage (V_{ARC}) and lamp current (I_{LAMP}) of 400-watt E-H1 lamp started over standard reactor. The unsymmetry of the lamp current reflects the unsymmetry in the arc voltage, not the rectification itself. Bilateral rectification can be recognized from the arc voltage, not the lamp current.

por lamp acts as a d-c generator rather than as a rectifier. The effect of the generated direct current (I_{dc}) on the wave shape of the arc voltage (V_{LA}) is depicted in Fig. 6. Those graphs are derived from a schematic dynamic lamp characteristic, based on a sinusoidal lamp current (I_{ac}). This procedure has been chosen to demonstrate the effect of the d-c voltage variation on the standard reactor. Actually the mechanics are as follows: The sinusoidal lamp current causes a certain voltage drop across the arc similar to Fig. 6 C a. The counter-EMF in the lamp becomes unsymmetrical, resulting in a d-c counter-EMF. This way, the resulting lamp current wave becomes distorted so that actually the current wave is similar to the voltage wave shape in Fig. 6 C b rather than to the wave of Fig. 6 B b.

No matter how the shape of the lamp current looks, the effect of the d-c generation on the choke is very much alike. Fig. 7 shows the influence of the direct current and the d-c voltage on the hysteresis curve and the flux density of the reactor. The positive current displacement results in a shortage of the negative portion of the hysteresis. The rising slope is increased by the rise in d-c voltage, while the falling hysteresis slope is diminished by the descending d-c voltage. This means that the positive a-c counter-EMF of the lamp affects the choke impedance inversely in two subsequent half-cycles of the voltage wave. At the same time, the hysteresis loop area becomes narrower, resulting in diminished hysteresis losses. The coercive force of the core is reduced; but the residual density is almost the same as it is without d-c excitation.

The same theory as developed for a reactor applies to a leakage reactance transformer. The relation between the primary inrush current (or the line inrush), the lamp alternating current, and its d-c component is as follows: (Fig. 5)

The maximum instantaneous current ($i_{max\,LA}$) is determined by the fact that no matter how high the flux of a coil might be, the iron will be unable to carry more than about 135,000 lines per square inch times the cross-sectional area of the core in inches. The total peak flux in the core equals the product of the cross-sectional area of the core and the sum of the residual flux density B_{res} and twice the maximum flux density B_{max}. The space flux density B_s then yields as:

$$B_s = \frac{A_c}{A_s}\,(B_{res} + 2\,B_{max} - 135{,}000)$$

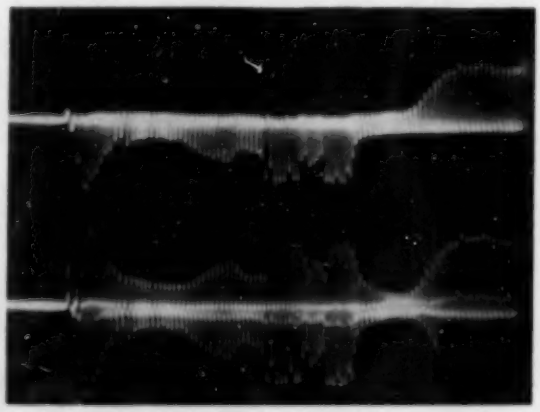


Figure 5. Lamp current (I_{LAMP}) and line current (I_{LINE}) of 400-watt E-H1 lamp when started over ballast on 110-volt line.

where A_g is the effective cross-section of the air-core magnetic field within the excited winding (Blume). The maximum instantaneous inrush current in a coil combination of a total winding length of h inches and N turns in series will then be:

$$i_{max} = \frac{h B_g}{3.2 N} = \frac{(B_{res} + 2 B_{max} - 135{,}000)\, h A_C}{3.2 N A_g}$$

This value represents the highest possible peak value of the primary (or line) current under the most adverse conditions. We cannot think of a more adverse condition than the operation of a mercury vapor lamp with its negative resistance characteristic. This means that during the arc stabilization, the maximum instantaneous current value may occur several times before the lamp enters the warming-up or actual starting phase. It is noticeable that the occurrence of the tremendous crest value is not bound to the instant where the lamp ballast is being connected to the power supply. In some respects, the lamp performance may be compared to a switch opening and closing the secondary winding of the ballast. The time constant of the corresponding transient then is either:

$$T_{sc} = L_{sc_1} / R_1$$
$$\text{or} \quad T_{sc} = L_{sc_2} / R_2.$$

Actual average values are given in the table of ballast and lamp data. The open circuit time constant (T_{oc}) is 0.9, 1.3, and 1.7 seconds for the 400-, 700- and 1000-watt lamp, respectively. The short circuit time constant (T_{sc}) is about 0.2 sec. for any of these ballasts. The actual time constant of the secondary circuit, however, is determined not only by the d-c resistance of the circuit, but by the variable a-c resistance (R_{ac}) of the ballasting reactance

$$R_{ac} = \frac{\text{Watts}}{I^2}$$

and the negative resistance of the lamp as well:

$$R_n = -\frac{dE}{dI}$$

Therefore, the denominator of the time constant consists of three different resistances, two of them being variable. Under the assumption that the reactive voltage drop V is linearly proportional to

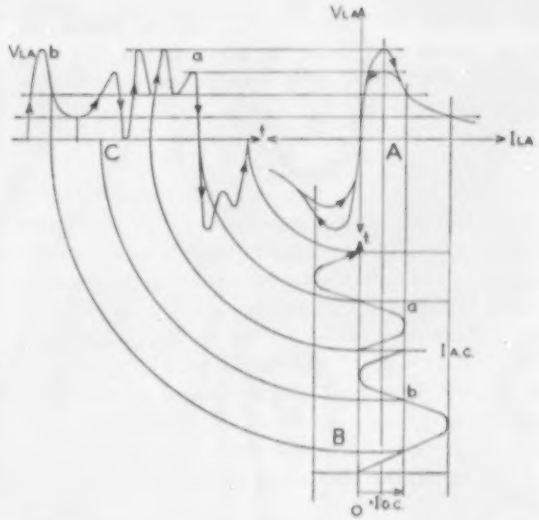


Figure 6. Mercury lamp characteristic (V_{LA} vs. I_{LA1} in Section A) and wave of lamp voltage (V_{LA} in Section C) with pure a-c lamp current (I_{AC} in Section Ba) and with d-c component (I_{DC} in Section Bb) in lamp current.

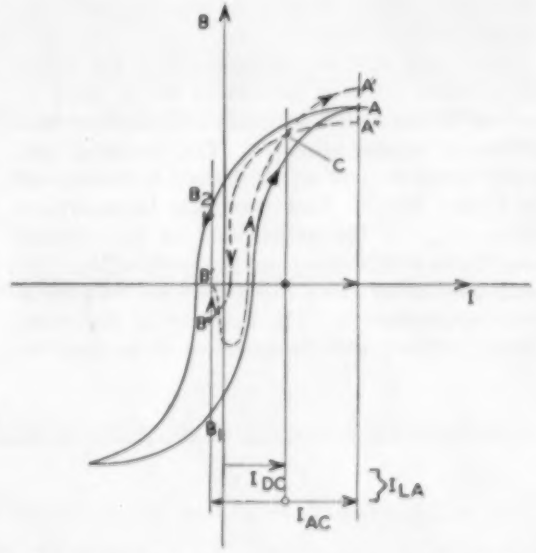


Figure 7. Distortion of the hysteresis loop in the reactor during the period of d-c generation by the lamp.

TABLE I.—Rated Lamp Data and Empirical Ballast Data.

Lamp						Ballast			
Wattage	Type	E_{ac}	V_{oper}	I_{st}	I_{oper}	R_{dc_2}	L_{sc}	R_{dc_2}	L_{sc_2}	$R_{sc_{max}}$
400	E-H1	300	135	5	3.2	.6	.53	1.0	.056	2.5
700	A-H18	460	265	5	2.8	.25	.33	1.6	.324	2.0
1000	A-H12	230	135	12	8.2	.1	.17	.3	.202	1.5

the current, the inductivity L may be considered to be constant. During the stabilization, the time constant then becomes a function of the variable stabilization resistance:

$$R_{Stab.} = R_{dc} + R_{ac} + R_n$$

The table shows the maximum R_{ac} resistance. The actual values vary from zero to that maximum value. The negative lamp resistance varies within a range of zero to a maximum value approximately equal to the short circuit stabilization value where the voltage drop across the arc reaches its minimum (E_{min} = 15 volts). The maximum negative resistance then becomes 15 volts divided by the short circuit or starting current of the lamp. The range of the variation of the stabilization resistance as computed under the above assumptions is as follows:

Lamp	R_{stab}
400-watt E-H1	−2.0 to +0.5 ohms
700-watt A-H18	−1.4 to +0.5 ohms
1000-watt A-H12	−1.0 to +0.55 ohms

The negative resistance values signify the surge, while the positive values apply to the decay. In general, the resistances causing the surge are higher than the positive resistance values, resulting in surge duration periods being shorter than the duration of the decay period.

This shows that the performance of the lamp-ballast combination is determined by the lamp as well as by the ballast and that both of them contribute to reliable operation. The maximum primary inrush current of the ballast is determined by ballast design. That maximum instantaneous value (i_{max}) is the upper limit of the steepest amplitudes occurring during the stabilization. The lamp alternating current then is given by the turns ratio approximately. The linearity of the transformer together with the variation of the negative lamp resistance determine the surge and the decay rate of the a-c component of the lamp current. The d-c component then cannot be exceeding $\sqrt{2}$ times the maximum lamp alternating current.

There are three ways to improve the inrush conditions:

(1) By limiting the maximum instantaneous value (i_{max}) of the ballast (good linearity, low density, proper core and coil construction) and the variation of the negative lamp resistance (R_n).

(2) By eliminating the d-c component of the lamp current (condenser in series with the lamp).

(3) By compensating the d-c voltage within the secondary circuit (producing a compensating voltage of about 15 volts which is about 180 degrees out of phase with the lamp current).

Any of these solutions brings about certain shortcomings in either economical or technical respect. Still the best way to ensure proper performance consists in:

(1) Designing the ballast to low transients,

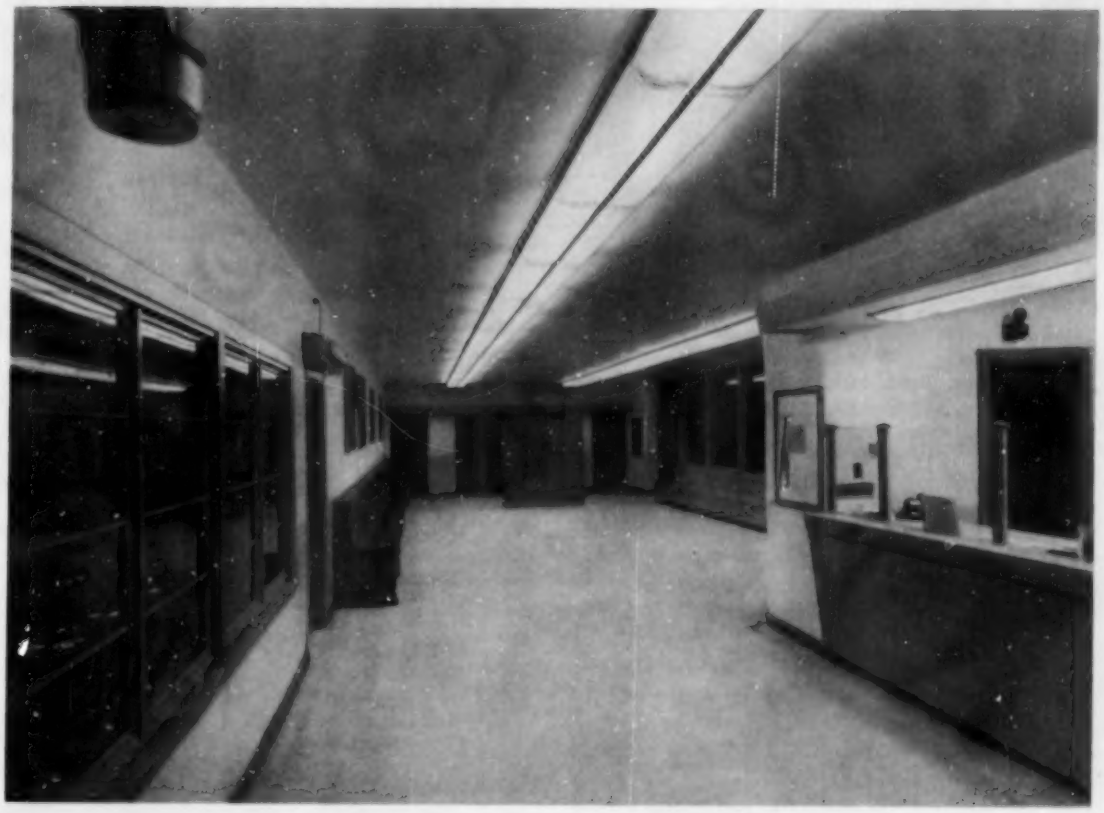
(2) Designing the lamp as symmetrically as possible and,

(3) Manufacturing the lamps within arc voltage limits closer than from 120 volts to 150 volts for a lamp rated at 135 volts. As the arc voltage varies inversely with the lamp current, the effective lamp resistance of an E-H1 or A-H1 400-watt mercury vapor lamp varies from 33.4 to 42.2 to 52.1 ohms, when the actual arc voltage varies from 120 to 150 volts. This means the ballast is subject to a variation in the load of −21 per cent to +24 per cent. It is expected to carry a 13 per cent overload in current when operating a low voltage lamp and to safely start a lamp with an igniting voltage approximately 20 per cent over the value at which the arc of a lamp with rated values would strike. These are but a few of the problems in designing a ballast which still shall be competitive.

I.E.S. National Technical Conference

September 12-16, 1955

Hotel Statler **Cleveland, Ohio**



INSTALLATION AT BOSTON AND MAINE RAILROAD STATION, LYNN, MASSACHUSETTS.

Lighting a Railroad Station

LIGHTING OBJECTIVE: To provide general lighting in a suburban railway station and supplementary lighting at the ticket window.

GENERAL INFORMATION: Fig. 2 shows the layout of the area shown above. Colors and reflectances are as follows:

ceiling	egg shell	70% RF
walls		
upper	cream	60% RF
lower	beige	37% RF
floor	terra cotta	25% RF
benches	oak	20% RF
counter top	light oak	35% RF

INSTALLATION: General lighting in the waiting room is provided by twenty-three Holophane (No. 9302-4) lighting units, each containing two fluorescent lamps. Three Holophane (9304-4) lighting units, each with four fluorescent lamps provide the general lighting in the ticket office. Supplementary lighting over the ticket counter is provided by three Holophane (No. 9202-4)

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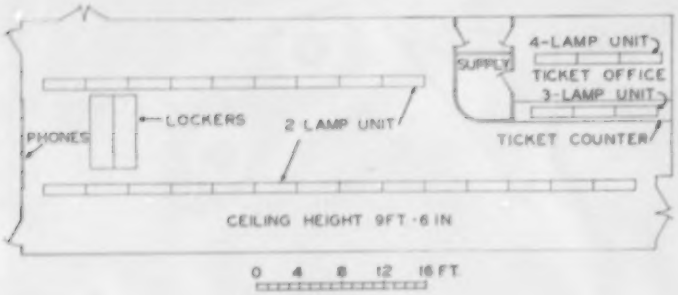

Fig. 2. Plan view.

lighting units, each with three fluorescent lamps. The distance from these units to the ticket counter is four feet. All fluorescent lamps are 3500K white, four-foot, bi-pin, preheat starter type.

Illumination levels are as follows:

benches	
side of waiting room	25 footcandles
corners of waiting room	17 footcandles
pay lockers	
on floor	25 footcandles
3½′ above floor	28 footcandles
center of waiting room	
on floor	42 footcandles
3½′ above floor	45 footcandles
entrance	
main	34 footcandles
back	24 footcandles
ticket office	
on desk	74 footcandles
ticket counter	
customer's side	60 footcandles
agent's side	83 footcandles

Brightnesses are as follows:

ceiling luminaire	
crosswise at 45°	550 ft-L
crosswise at 30°	530 ft-L
lengthwise at 30°	930 ft-L
ceiling	
between units	8.2 ft-L
near units	30 ft-L
wall	
upper side	9 ft-L
end of counter	10.5 ft-L
front of counter	3 ft-L
bench	2.2 ft-L
lockers	3 ft-L
floor	12.2 ft-L

Lighting data submitted by J. Robert Cornell, Jr., Lynn Gas and Electric Company, 80 Exchange Street, Lynn, Massachusetts as an illustration of good lighting practice and to aid in the design of similar installations.

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Lighting Education in Continental Western Europe

By W. A. HEDRICH

DURING the summer of 1954, the writer devoted nine weeks to a study of lighting education in Continental Western Europe, having spent the greater share of this time in Western Germany, Switzerland, and The Netherlands. Arising out of the purely informative aspect of the following brief account, it is hoped that the reader whose interest lies primarily in lighting education and, in particular, the I.E.S. Lighting Education Committee and the United States National Committee 4.1.1 (C.I.E.) on Lighting Education in Schools, Colleges, and in Professional Circles will entertain consideration of educational procedures indigenous to the European setup, which could, perhaps, with some modification be employed in effecting a solution to some of our problems.

The *broad* structural units which make for lighting education are:

(1) Educational Institutions.

(2) Technical organizations and commissions for promoting the advancement of any or all of the following for the general welfare of society: theory, experimentation, application, utilization, management, and publication.

(3) Public Utilities.

(4) Industry.

For lighting education to be effective, these factors must be adequate and properly correlated. They cannot stand alone, although it is possible within certain limitations for one to incorporate the functions of another.

Since the greatest *overall activity* in the lighting field in Western Europe today is centered in Germany and in the Netherlands, it may be well to review the educational status in Western Germany.

Western Germany

Educational institutions for the dissemination of knowledge pertaining to light and illuminating engineering existing during 1953-54 may be classified as:

(1) Higher Institutes of Technology (Technische Hochschulen).

(2) Technical Schools (Technische Fachschulen).

AUTHOR: Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

The Higher Institutes of Technology are located at Karlsruhe, West Berlin, Hanover, Stuttgart, and Munich.

There are five others, but they offer essentially no work in lighting.

All of these schools offer the usual power and communication-electronics options in electrical engineering. Karlsruhe and West-Berlin, however, also feature an Illuminating Engineering Option in Electrical Engineering, which is implemented in each case through a Lighting Institute. The Institute had its inception at Karlsruhe about 1922, and is today the foremost center in Germany for intensive theoretical training, testing and research in illuminating engineering.

Higher Institutes of Technology (Technische Hochschulen)

Karlsruhe — The cooperation of West-German industry with the Lighting Institute at Karlsruhe must be emphasized at this point, because the Institute is subsidized mainly by industry and only to a small extent by the West-German Government. A society known as the *Hochschulgemeinschaft fuer Lichttechnik* (Manufacturers' Technical Association for Lighting) consisting of a voluntary merger of some 20 to 25 light source and fixture manufacturers, provides a yearly stipend for lighting instrumentation and research at the Lighting Institute. Industry's support is rewarded by the caliber of the Lighting Institute's output, as the standards maintained at Karlsruhe are high.

If a student subscribes to the Illumination Option, his third and fourth years are predominantly devoted to lectures and laboratory work in illumination and physics. A student electing the power option, cannot elect illumination engineering as a minor, but may elect courses in lighting as free technical electives. Students in the communications option can minor in physics, chemistry, power or illumination. However, if this work is chosen in illumination, considerably more course work is required than the power option candidate may choose from his free technical elective group. The obvious inference is that illumination is of relatively greater importance to a communications man interested in lighting than it is to the power major having the same interest. Judging from a

review of the option requirements, this can be justified only on the basis that the communication candidate's interest be most naturally confined to the physics of light sources.

At Karlsruhe a one-year advanced study program in lighting is being contemplated for those who have already received their undergraduate degree in electrical engineering elsewhere. The program is sponsored by industry. Tuition is paid for this fifth year of study by industrial lighting firms in West-Germany provided the student obligates himself to become affiliated with a West-German manufacturer of light sources or lighting equipment over a five-year period following his completion of this industry-sponsored training in illumination.

Graduate work in illumination at Karlsruhe is open to those who have received their undergraduate degree in the illumination option. In addition to recommended lectures on advanced topics in mathematics, physics, chemistry and lighting, the student is expected to carry on independent experimental research, write a dissertation, and pass both oral and written examinations.

A further effort to promote lighting education at Karlsruhe in 1953 marked the beginning of a special course in lighting for the benefit of instructors in electrical engineering and in architecture from other engineering schools. This course, initiated through the German Illuminating Engineering Society, had an enrollment of 24 instructors who met ten hours per day for three consecutive days. The lectures and consultation services were gratuitously given by the regular staff, and transportation expenses were defrayed by the delegates' schools.

Berlin — The Higher Institute of Technology in West-Berlin, now known as the Technical University of Berlin, likewise has a Lighting Institute. However, due to the rather extensive demolition during the second World War, buildings and other physical properties of the university are still being reconstructed or replaced by new ones. Progress has also been retarded by lack of sufficient funds to replace buildings, laboratories and equipment.

The options are the same as at Karlsruhe. The illumination option requires four lecture courses in lighting, three semesters of laboratory work, and a course in the design of lighting installations. Here as well as at Karlsruhe and at all higher institutes of technology a thesis is required of the candidate for any undergraduate degree regardless of option. It is to be noted that the illumination option course work requirement is somewhat less extensive than that at Karlsruhe.

Students in the power and communication options may elect illumination as a free technical elective in which they wish to be examined at the close of their senior year.

The Technical University of Berlin has offered elementary and advanced lecture and laboratory courses in lighting ever since the early years of the twentieth century. These courses served as technical electives for physics and electrical engineering students in the undergraduate curriculum. It is only comparatively recently that this university has established and maintained a Lighting Institute. Its facilities, although somewhat limited at present, provide a sound basis for extended activity in lighting research.

Hanover — At the Higher Institute of Technology in Hanover there is no illumination option, but illumination constitutes a required technical elective for electrical engineers and architects. Two courses are required of both groups: "Daylighting and Artificial Lighting" and "Design of Lighting Installations." The electrical engineers must also elect another course in illumination as well as a laboratory course in photometry.

Stuttgart and Munich — At Stuttgart and Munich the Higher Institutes of Technology offer an elective in illumination for students of electrical engineering, consisting of lectures covering the general field of lighting. There is no illumination option at this school.

The Technical Schools (Technische Fachschulen)

The Technical Schools in Western Germany number about 65 of which 30 offer some fundamental work in illumination. But this is not in the form of a course in illumination proper. The work in lighting is self-contained in other courses such as physics and some electrical engineering subjects. One exception is at Bingen on the Rhine where a special course in lighting is being given.

Technical Organizations

Contributing to Lighting Education in Western Germany are the following organizations:

(1) *Illuminating Engineering Society (Lichttechnische Gesellschaft).* This was founded 1912 in Berlin, lay dormant during the last World War, and was revitalized 1950. It has a total membership of about 860, of which 300 members are highly-trained technical men, 300 are practicing engineers, and the remainder are sales representatives, professors, management personnel, etc. The society has eight sections; holds ten meetings per year. It embodies five principal committees or commissions.

(2) *The Hochschulgemeinschaft fuer Lichttechnik* has already been referred to above.

(3) *Studiengemeinschaft Licht e.V.* This is an organization promoting the study of light. With headquarters at Wiesbaden, it is founded in the interest and for the benefit of the public, and is financed by leading lamp manufacturers, like Osram and Philips, whose purpose is to disseminate illuminating engineering knowledge of common interest and usefulness through demonstration lectures and publication. It promotes good lighting.

(4) *The Illuminating Engineering Standards Commission.* This is a sub-commission of the German Standards Commission. The latter, incidentally, is the only organization of its kind in which Eastern Germany has full representation.

Periodicals

There are a number of very good periodicals in West-Germany pertaining to light and illuminating engineering covering both theoretical and practical phases. Some of the more recent textbooks on illuminating engineering provide exceptionally good material on the physiological and aesthetic aspects. The most important current publications include: *Illuminating Engineering, Optics, Journal of Physics, Annals of Physics, Journal of Applied Physics, Color, Electrical Engineering,* and *The Building Trade.*

Student Activities

Student activities in the lighting field are limited to occasional inspection trips conducted by the various schools. Those majoring in illumination are encouraged to acquire practical experience in this field during the vacation periods. There are no student branches of the Illuminating Engineering Society under the advisorship of faculty men.

Industry

All lamp manufacturers and the leading fixture manufacturers maintain their own testing laboratories. However, industry subsidizes a testing laboratory at the Lighting Institute at Karlsruhe for non-routine tests, experimental research and tests on lighting equipment for motor vehicles.

It is principally the degree in which the lighting industry cooperates with educational institutions that signals intent and purpose — to create a real market for the prospective illuminating engineer. This realism must be coexistent between employer and employee. The current situation in this field throughout Western Germany still reflects a demand for well-trained lighting engineers which the present supply cannot meet, but the situation is on the mend. The average beginning salary for the prospective lighting engineer is the same as that for power and electronics men.

The occupational range for students with some training or with specialized training in illumination is not essentially different from what it is in the United States. Light-source manufacturers absorb men in three fields: pure research, development and manufacture. Fixture manufacturers place their men in construction, design of luminaires and lighting installations, and with sufficient experience they may become consultants. Throughout the lighting industry, the demand for well-trained men with creative leadership is greater than the schools can supply.

Cooperation Between Lighting Engineers and Architects

The lighting industry in Germany is always ready to cooperate with architects. In general the initiative is assumed by the lighting engineer. By means of a Supplement which accompanies the *Building Trade* periodical, the lighting engineer is apprised of building projects quite some time before actual work is begun, which enables him to contact the architects in time to be of service. When lighting engineers are engaged in planning a street-lighting installation, the municipal architects act in an advisory capacity to ensure that the masts to be installed harmonize with the existing architecture of the neighborhood. The leading fixture manufacturers provide conferences for the express purpose of encouraging members of the German Illuminating Engineering Society, architects, and members of the Electrical Engineering Society to acquaint themselves with the latest developments in fixtures and their applications. The Hanover Fair (formerly at Leipzig), an annual event, provides opportunity for architects and the building trade to examine latest fixture types. The number of architects who usually avail themselves of this opportunity is gratifying.

Austria

Lighting education in Austria has been delimited by her postwar political and economic status. There is no Lighting Institute in Austria, nor is there any Austrian periodical in the lighting field. Recourse is had to the German monthly publication already referred to — *Illuminating Engineering, (Lichttechnik).* The Higher Institute of Technology at Vienna offers one lecture course in fundamentals of illumination. In the advanced trade school group there are nine schools which give a one-semester course in elementary lighting principles. A relatively small group of architects, regardless of whether they are enrolled at the technical institute at Vienna or engaged in trade school work, is *required* to subscribe to a one-semester

course in illumination. Students in electrical engineering are free to choose illumination as an elective. Efforts to raise illumination to the rank of a required course for electrical engineering majors at Vienna have failed. No illumination laboratory work is offered in any of the schools in Austria. Lack of funds has curtailed progress in this direction.

Night-school courses covering elementary work in lighting are available for those who are employed full time in various engineering enterprises. The Electrical Engineering Society of Austria helps to stimulate lighting education by providing speakers on topics of interest to the lighting engineer. The Industrial Association of Illuminating Engineers also promotes activity in this field.

Lack of funds seems to be a decisive obstacle to necessary or desirable normal and advanced training, not only in the lighting field, but quite generally.

Switzerland

A questionnaire was submitted to the Swiss Illuminating Engineering Committee for consideration of 13 pertinent questions covering the role of lighting and illuminating engineering in the Swiss educational system. Chairmen of the various subcommittees assumed the responsibility of filling out the questionnaire.

Apart from the Confederate Higher Institute of Technology at Zurich, there are five universities, six technical schools and five trade schools. Three of the universities are non-technical and thus offer nothing in the lighting field.

The Institute of Technology at Zurich has no separate division for illuminating engineering, no professorship in illuminating engineering, no instructors in this field. A two-hour course in consumer electrical installations is offered every winter semester and is administered by a consulting electrical engineer from Zurich. It is a purely elective lecture course. Attendance is low — few electrical engineering students, few architects. Since 1951 the electrical engineering laboratory includes about six experiments on light plus an additional four to six experiments for those especially interested. The laboratory work is principally devoted to the physics of light and light sources, involves some spectography but no lighting applications.

During the winter semester of 1951-1952 a course was given at this school by members of the Swiss Illumination Committee. It was conducted as a symposium. The lecturers were men well qualified in fundamentals and photometry, physiology, quantum theory, light production, street lighting, and calculation of interior lighting installations. The attendance settled down to about 100 people of which 90 per cent were men on technical and sales staffs, and the remainder were students. This *might* indicate a belated realization of the relative significance of formal lighting education. The lectures were supplemented by mimeographed notes for the benefit of those enrolled in the course. A possible repetition of this course is pending completion of preparatory work.

The Swiss Illumination Committee has made several unsuccessful attempts to convince the governing Board of the need for a professorship in illuminating engineering. Reasons for the refusal include general lack of interest in the lighting field, departmental overload, and the impression that sufficient attention is devoted to lighting by the technical schools throughout the country.

An institute for occupational hygiene at this school under the guidance of a medical doctor well versed in the physiological aspects of light, provides opportunity for engineers and architects to discuss the application of light as related to hygiene.

Universities

At the École Polytechnique de l'Université de Lausanne there is some small interest in lighting, perhaps to the extent to which it is related to elementary college physics. There are no courses in lighting proper.

The University of Bern offers a course in photometry as contained in a course in engineering physics.

Technical Colleges

These colleges, located at Winterthur, Burgdorf, Bienne, Fribourg, Geneva and Le Locle set an entrance requirement of from one to three years of practical training in electrical work generally obtained at a trade school. Power and communication options are available. The work in lighting, however, is quite introductory, and laboratory work is limited. The college at Winterthur is probably the most progressive in this group.

Publications

With the exception of a good Handbook on Lighting, published 1950, the Swiss periodicals conform to the general pattern of including material on lighting and illuminating engineering in the broader field of electrical engineering.

Organizations

There are four principal organizations in Switzerland that have a bearing on lighting education.

(1) *Swiss Illumination Committee* (Das Schweizerische Beleuchtungskomitee). This is the Swiss

National Committee of the International Commission on Illumination.

(2) *The Swiss Illuminating Engineering Association* (Schweizer Lichttechnischer Verband). This was founded anew in 1953 to safeguard the profession.

(3) *Lighting Administration Headquarters* (Zentrale fuer Lichtwirtschaft). This was founded about 1927 by the lamp industry, the Swiss Power Plant Association, and the Association of Swiss Installateurs. It is a clearing house for consultation, propaganda and education. It has promoted several courses throughout Switzerland in lighting installation and offers extension courses at Zurich and Winterthur.

Switzerland conducts no independent research in the lighting field.

Student Activities

There are no student branches of the Illuminating Engineering Society. Student activities are limited to occasional inspection trips conducted by the various schools. The status in this respect in Austria is even less encouraging.

The Netherlands

The higher educational system in The Netherlands is subdivided as follows: Technical Schools and Universities.

The technical schools turn out some engineers, designers and management personnel; the remainder of their output is channeled into the technical university. The universities, in turn, provide the raw material for industrial research, engineers, and management of commercial and technical groups.

The training of lighting engineers in The Netherlands is achieved mainly at the Philips Gloeilampen Fabrieken at Eindhoven. The prospective lighting engineer receives both theoretical and practical training at this formidable European lighting center. Since Philips is the training center for people interested in lighting as a career, the advisability of clarifying the educational setup in The Netherlands is obvious.

People interested in lighting education come to Philips with various educational backgrounds. The introductory training prior to entering Philips in conjunction with the qualifications and aspirations of the applicants determine the nature and extent of the training course such applicants will receive at the plant. In general there are four groups absorbed by Philips:

(1) Commercial groups with very little technical training.

(2) Technical groups with perhaps three or four years of technical school training.

(3) A group which is interested in training for service in the Dutch railways as lighting engineers.

(4) Students from the universities of Delft and Utrecht.

Universities in The Netherlands offering some lighting education are located at Delft and Utrecht. Professor Halbertsma, pioneer of illuminating engineering at Philips, still conducts a lecture course at the University of Utrecht for students of physics who are interested in special work in lighting.

The Division of Electrical Engineering at the Technical University of Delft offers some work on the physics and physiology of light, light sources, and practical lighting methods. The practical work is more or less confined to a consideration of the possibilities within the realm of daylighting. A limited coverage includes lectures on the laws of radiation and the lighting art.

Periodicals

Aside from some eight or ten exceptionally good technical books on light and lighting, included in the Philips' Technical Library and written by its engineers for practicing engineers and technicians as well as for students in higher educational technical schools, their principal publications are:

(1) *Philips' Guide for the Illuminating Engineer.* 1951. The original edition, published in 1941, was designed principally for the Philips' illuminating engineering personnel. The 1951 edition, improved and supplemented by current practice, is available at large.

(2) *Light.* This is published monthly by the Philips' Sales Division and presents practical lighting installations developed by its engineers.

(3) *The International Lighting Review.* Published in Amsterdam, the *International Lighting Review* presents classical treatment of modern lighting installations at home and abroad.

Organizations

Among the Dutch organizations that help to promote lighting education, there are:

(1) *The Illuminating Engineering Society.*

(2) *The Holland Tourist Club.* This group cooperates with the automobile club in organizing courses in lighting for city officials and architects. Among the topics for discussion, the lighting of public buildings and streets are foremost.

(3) *Society for Promotion of Training for Electrical Contractors.* This society organizes courses in electrical contracting involving lighting. A seven-year training period, satisfactorily completed, entitles the trainees to a diploma. This is considered equivalent to a governmental diploma, a certification that the holder is authorized to carry

on independently as an electrical contractor.

In this very brief account, it is impossible to elaborate on the important role which the lighting industry plays in lighting education abroad. For the same reason, it is not feasible to dwell upon the nature of the questionnaire submitted to the Swiss Illuminating Engineering Committee. Let it suffice to mention that those countries which do not afford the most extensive training and research in the higher scholastic treatment of illuminating engineering usually provide a more comprehensive program for the elementary levels, exemplified by trade schools and the lower technical schools.

Advisory assistance from Messrs. A. A. Brainerd, President of the U. S. National Committee, C.I.E.; H. H. Magdsick, Chairman of Papers Committee, C.I.E.; C. L. Crouch, Technical Director, I.E.S.; Professor E. M. Strong, Past President of I.E.S.; and W. A. Stannard, Director of I.E.S. is here gratefully acknowledged.

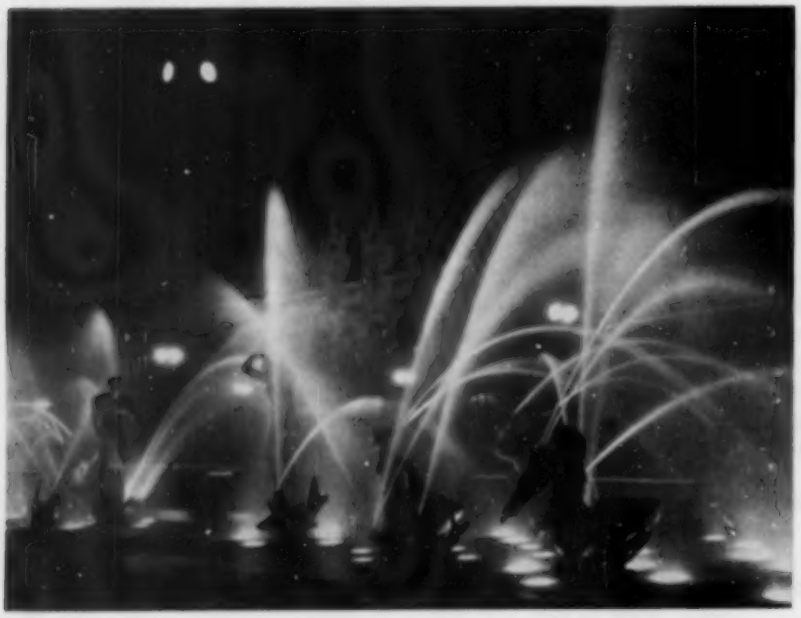
Floodlighting "The Meeting of the Waters"

The Milles Fountain, named the Meeting of the Waters, is the world-famous group of 19 bronze statues, designed and cast by Swedish sculptor Carl Milles. Located in Aloe Plaza, in St. Louis, the statuary symbolizes the meeting of the Missouri and Mississippi Rivers a few miles north of the city.

At the time of the design, Mr. Milles did not favor the idea of floodlighting the fountain — indeed he threw an electrical salesman out of his office when he was approached on the subject. But years later, the sculptor agreed that lighting the streams of water and the bronze statues would increase their beauty and effectiveness.

After studying various methods suggested, Carter Lewis, of Union Electric Co. of Missouri, selected a system of underwater floodlights, lighting the statuary and spray from below, with higher levels on the center groups of figures. A total of 96 floodlights, with 400-watt G-30 lamps, are mounted totally submerged, with beams directed at the statuary 20 degrees off vertical.

This installation won second prize for William H. Simms, illuminating engineer with Union Electric Co. of Missouri, in the St. Louis Section's contest for My Most Interesting Lighting Job. Electrical contractors were the Fremder Electric Co., St. Louis.



INSTALLATION IN COLUMBUS, OHIO.

Soffit Lighting in a Kitchen

LIGHTING OBJECTIVE: To provide 40 footcandles or more at sink, range and work counter of a kitchen.

GENERAL INFORMATION: The kitchen and breakfast room combined is 10 feet by 16 feet 6 inches. The wall area of the ell-shaped kitchen work center is 9 feet by 7 feet. The ceiling is 8 feet. The reflectances of the light wood cupboards are 44%, the yellow plastic laminate counter 65%, white ceiling 80% and the light gray-green floor 50%. The wall under the wall cupboard is light yellow 80%.

INSTALLATION: A wood soffit is dropped 12 inches from the ceiling along two walls of the kitchen, forming an ell. Recessed in the 8-foot soffit are two 25-watt and one 40-watt deluxe warm white fluorescent tubes. In the 6-foot soffit are two 25-watt and one 15-watt tubes. The tubes are arranged to make a double run over the sink and over most of the range and the adjoining work counter. The counter at the corner benefits from the light coming from both directions. The bottom of the soffit is covered with three sections of frosted glass which rest in the soffit frame work. Distance from bottom of tubes to glass is 4 inches.

(over)

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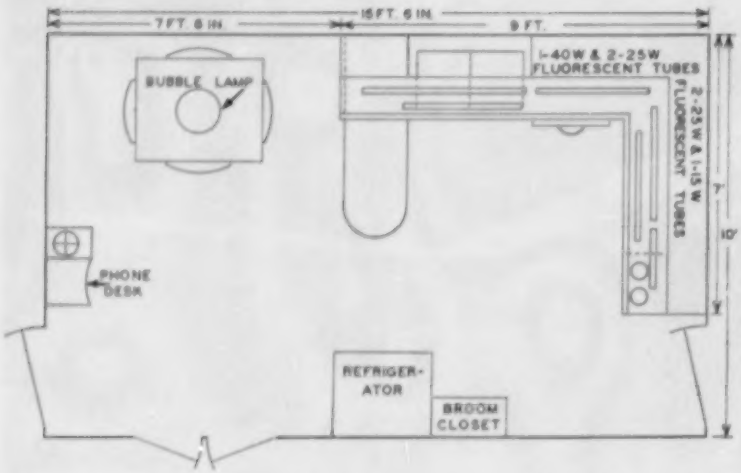


Figure 2. Plan view of kitchen and breakfast room.

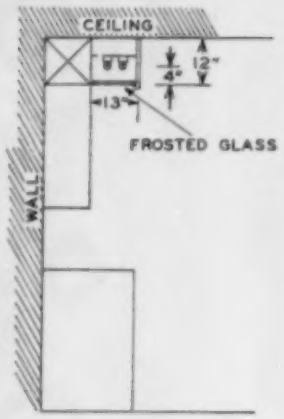


Figure 3. Elevation of work center.

Illumination measurements taken after 100 hours of operation were:

Center of Sink	47 footcandles
Center of Work Counter	46 footcandles
Center of Range	49 footcandles
Horizontal Plane 36" above floor	
Near Counter	47 footcandles
Near Refrigerator Wall	5 footcandles
Average	30 footcandles

In the breakfast area an 18-inch bubble ball in plastic by the Miller Clock Co. is hung from the ceiling over the table. In it are two 60-watt lamp bulbs which give 15 footcandles in the center of the table. A small table lamp is placed on a small telephone stand.

Lighting data submitted by Blanche Waggener, Columbus and Southern Ohio Electric Company, Columbus, Ohio as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminatng Engineering Society, 1860 Broadway, New York 23, N. Y.

To be successful, restaurants must be attractive, neat and appealing. Application of the lighting elements — and especially their maintenance — has an important part in this, as exemplified by this successful

Small Snack Shop

Rickey's Snack Shop in San Diego, Calif., though small (only 16 feet by 63 feet) is now accommodating well over 500 customers a day. Its owners trace its success to the lighting, which was planned especially to overcome the ever-present problem of cafes — maintenance. Collection, on lamps and louvers, from particles of grease in the air calls for constant care of the fixtures — but restaurants, of all places, seldom set up a maintenance program. In Rickey's, eighteen 4-foot, 3-lamp rapid start luminaires, with their Plexiglas covering almost flush with the ceiling, are readily restored to their original luster with a simple wiping. These units are mounted crosswise in the room for a psychological increase in room width. For sparkle over the stainless steel bar, eleven recessed controlite fixtures have been employed, lamped with 150-watt incandescent lamps. General illumination averages about 70 footcandles. Interior colors are, of course, of good reflectance values, in light brown, light green, with a gray floor and white on the 9-foot 6-inch ceiling.

Lighting design is by D. F. Curtis, San Diego Gas and Electric Co., who supplied the pictures and text. The installation won for Mr. Curtis the second prize in the contest for "My Most Interesting Lighting Job" conducted by the San Diego Chapter of I.E.S.

Here and There with IES Members

Attendance was 115 at the meeting when the Eastern Pennsylvania Section conducted its contest for My Most Interesting Lighting Job. Here the winners are shown with the contest Chairman, left to right: Frank Heins, third prize; Francis E. Glick, second; Harry Weidman, first place winner; and Chairman Paul Kinsey.

Judges and the first place winner in the Ohio Valley Section's MMILJ Contest: left to right are H. K. Flint, Judge; C. W. McFee, Judge; Harold J. Gruber, first prize winner; and E. T. Glaser, Judge.

Michigan Section Program Chairman Edwin Miller, far right, presents awards to MMILJ winners. From left to right are: E. Burton Wolfe, third prize, Mary Taepke, second, and first prize winner, Harold Fisher, receiving the certificate.

U. S. Submarine Base, in New London, Conn., was the site of a meeting of the Connecticut Section, IES, when the men were allowed to make an inspection tour of the U.S.S. Trout, one of the last submarines commissioned prior to the building of the U.S.S. Nautilus. Left to right are: Commander Dean Farnsworth; R. O. Mills, Section Chairman; C. W. McCormick, Regional Vice-President; Instructor; and Dr. Sylvester Guth, who was guest speaker at the evening meeting. Attendance was 87 at the meeting.

T E L E C A S T

LIGHTING NEWS OF CURRENT INTEREST

I.E.S. Council Holds Meeting in Phoenix, Arizona. Summary of Action

A view of the national Council in action was afforded western members April 13, at the Council meeting held at the Westward Ho Hotel in Phoenix, Arizona. This was the farthest west ever ventured by Council. Some thirteen western members attended the meeting, some as proxy officers, as well as eastern officers who traveled to Phoenix for the meeting. Those present were: Duncan M. Jones, President, presiding; R. F. Hartenstein, Vice-President, and P. G. Young proxy for M. N. Waterman, Vice-President; Kirk M. Reid, General Secretary; J. S. Walsh and F. C. Winkler, Directors; G. B. Buck, II, D. M. Finch, C. W. McCormick, J. D. Whitnell proxy for M. J. Myers, Jr., J. A. Ware proxy for G. E. Park, L. A. Hobbs proxy for B. E. Plowman, Regional Vice-Presidents. Also present were A. D. Hinckley, Executive Secretary; Ruby Redford, Editor; Charles Bell, William Cyr, Marvin Dansie, Glenn Gaer, Ray Jonas, Bevan Jones and Douglas Peck.

New Members

The election of 22 full members of I.E.S. was approved, on recommendation of the Board of Examiners. The Board also reported their election of 121 Associate Members and one Student. With other changes, total membership is now as shown in the tabulation below:

September 30, 1954		April 13, 1955
7902	Total Membership	8333
34	Members Emeritus	37*
78	Fellows	78
1939	Members	1997
5621	Associate Members	5985
250	Student Members	236

*Includes 12 Fellows.

Kirk Reid, General Secretary outlined the activities of the Membership Committee this year, especially the monthly statements on current status as compared to the past three years at the same period. Mr. Buck described a system used in the Rocky Mountain Section in which all members' records are coded so as to point out automatically those eligible for full membership or member emeritus.

Appointment of a Committee of Tellers was approved, for the tally of annual officer elections. The personnel approved were: Richard S. Wissoker, Chairman, Edward L. Gluck, Fred J. Orman, Sherman Halpert, Morton Semel. Two alternates approved were Bernard Boylan and Norman J. Silver.

Sustaining Members

Membership was approved for six Sustaining Members as follows:

Colonial Premier Co.
466 W. Superior St.
Chicago 10, Ill.
Official Representative: Richard Weis

Esty Manufacturing Co.
1231 W. Monroe St.
Chicago 6, Ill.
Official Representative: Ben Trossman

Malloy-Robinson Co.
1701 S. W. Jefferson St.
Portland, Ore.
Official Representative: Geo. A. Robinson

Platt Electric Supply, Inc.
103 N. W. 14th Ave.
Portland, Oregon
Official Representative: Jack Reinhart

Rosemount Industries Ltd.
2090 Moreau St.
Montreal, Que.
Official Representative: Paul A. Ducasse

Stubbs Electric Co.
63 N. W. Park Ave.
Portland 9, Ore.
Official Representative: Richard M. Boynton

Minutes covering a number of Executive Committee actions taken at their meeting March 10, 1955 were discussed with the following actions taken:

Council approved the election of Paul F. Kauffman to the grade of Member Emeritus. Details of this honor are given in the About People section of this issue.

The name of the Advisory Board on Committee Personnel was changed to Advisory Board to the President, and its scope expanded.

A Committee on Allied Arts was established as a General Committee with a scope "To encourage and assist local competitions in allied arts, in cooperation with technical committees and interested local groups."

On recommendation of the Executive Committee, Council approved initiation of a procedure leading to A.S.A. approval of the "I.E.S. Guide for Electrical Measurement of Fluorescent Lamps," as an American Standard.

Approval was given to the publication in full in I.E. of the Report of the Lighting Design Practice Committee, "Calculating Coefficients of Utilization" together with appendix and supporting data.

Regional Activities

In the absence of M. N. Waterman, Chairman of the Regional Activities Committee, their report was presented by C. W. McCormick, who had presided at

Photo courtesy W. A. Cyr, *Electrical West*

COUNCIL MEETING, held in Phoenix, Arizona, April 13, afforded Western members an opportunity of seeing the I.E.S. national governing body in action.

Here and There With IES Members

Past-Chairman Night of the St. Louis Section counted 13 of the 18 former Section Chairmen. An attendance of 95 turned out to honor: left to right, J. J. Rhoades, '51-'52; Henry Arendes, '48-'49; F. P. Walter, '46-'47; P. V. Brown, '45-'46; T. P. Gleeson, '44-'45; F. B. Lee, '41-'42; Carter Lewis, 1938 (first Chairman); Edwin Lauth, '38-'39; Edwin Ryan, 42-'43; E. L. Ehret, '47-'48; W. H. Simms, '50-'51; L. M. Wallace, Jr., '52-'53; G. F. Herold, '53-'54. Brooks Chassaing, current Chairman, is at the podium. This meeting was held April 12, with B. S. Benson, of Benjamin Electric as guest speaker.

Members of the IES Street and Highway Lighting Committee in the Sears Roebuck lighted parking lot in Denver. The Committee held a two-day Forum on Street and Highway Lighting April 4 and 5.

Winners in the Oregon Section's MMILJ Contest are, left to right: second place, A. G. Miller and, first, Frank H. Reis. Entries were for "Utility Load Dispatching Center," and "Controlled Visual Environment."

Brooks Chassaing, Chairman of the St. Louis Section, presents the first place certificate to E. W. Stohlman, Jr., winner of the Section's contest for My Most Interesting Lighting Job.

the committee's meeting earlier in the day. Following presentation action was taken to accept the report and its respective recommendations, as follows:

Eastern New York Chapter was granted Section status.

El Paso, Texas, members were transferred to the New Mexico Chapter (instead of Southwestern Section), pending approval of all parties concerned.

Regional Conference dates and locations for 1956 were all agreed upon. Dates and places for the 1957 conferences are currently being worked out by the respective regional groups.

By-laws for New Mexico Chapter and Oregon Section were approved.

Formation of a Utah Section Residence Lighting Forum was reported. There are now six such Forums.

Extension activity in the Montana area is being considered by officers of the Inter-Mountain Region.

A study of ways, means and costs was suggested leading to a national I.E.S. program of lighting courses, booklets and visual aids. Such a study was referred to the Lighting Education Committee for report.

JUNE COUNCIL

Referring to earlier discussion and decision, the time and place for the June meeting of Council was reported to be June 9, at Lake George, New York.

George Jack, Chairman of the Southern Regional, opens proceedings at the Fort Harrison Hotel, Clearwater.

Southern Regional Conference Leads Off in Florida; Every Section Represented

The 1955 series of nine I.E.S. Regional Conferences was paced this year by the Southern Region, at Clearwater, Florida, March 31 and April 1. They set quite a pace too, with a program of twelve valuable papers, plus three major addresses and three open-forum meetings for questions and answers. Advance billing of the high-level speakers presented at this conference attracted representation from all of the eleven Sections and Chapters within the Region, with a total of 156 registered delegates. Special recognition is traditionally given in this Region to the Section having the highest attendance. For the fourth year in a row, the Southern Regional attendance plaque was carried off by the Georgia Section. Scene of the conference was the Fort Harrison Hotel in Clearwater.

Eight Sections and Chapters in the Region had entries in the contest for "My Most Interesting Lighting Job." The outcome of this:

FIRST PRIZE: George C. Schroeder, Jr.
New Orleans Section

SECOND PRIZE: L. Ralph Bush
Georgia Section

Heading the agenda was, of course, I.E.S. national President Duncan M. Jones of Montreal, who was guest of honor together with Regional Vice-President Glenn E. Park. Mr. Jones addressed the luncheon session, March 31.

SOCIAL PROGRAM

In addition to the pleasure afforded by a fore-taste of summer in Florida sunshine in March, delegates and their wives enjoyed a full program of fun, arranged by a thoughtful Entertainment Committee. Specially for the ladies was a luncheon and fashion show at the hotel's outdoor pool, a visit to the Florida Gulf Coast Art Center at Belleair, and a bus trip to Tarpon Springs which included luncheon at Louis Pappas famous Greek restaurant. This excursion also featured a boat trip, sponge diving exhibition and a tour of the city.

But that's not all. The social program for both delegates and their wives also included a cocktail party and water show at the hotel pool on the first eve-

Glenn E. Park, Regional V-P addresses the Conference. Florida Section Chairman Frank Moos at right.

Question and Answer period was a feature of each session. Shown here: Wally Weld, Charlie Amick, Gene Beggs, Ed Rambusch and Frank Moos.

Entrants in the Southern Region's Contest for My Most Interesting Lighting Job represented eight Sections and Chapters. First prize winner George C. Schroeder, Jr., is at far left.

Plug for the National Conference in Cleveland is made by Charles L. Amick, Conference Chairman, who was also a speaker at the Southern Regional.

ning, and a banquet and dance honoring President and Mrs. Jones as the closing session. For anyone lingering over the weekend, the Transportation Committee stayed on duty for trips to the greyhound races, golf courses, jai-alai games, and other attractions.

Technical Program

The excellent technical program presented at the Southern Regional Conference included the following subjects and speakers:

Thursday, March 31

Morning Session

Invocation, Reverend Robert E. Coleman, Jr.
National Anthem.
Opening Remarks, George N. Jack, Conference Chairman.
Welcome Address, Honorable Herbert M. Brown, Mayor of City of Clearwater.
Introduction of National President — Duncan M. Jones.
Introduction of Program Chairman — Frank Moos, Chairman, Florida Section.
Introduction of Session Chairman — James F. Fletcher, Mid-South Chapter.
Progress Report — E. W. Beggs, Westinghouse Electric Corp.
RLM Standards and need for same — Raymond Corwin, Benjamin Electric Mfg. Co.
Light Sources present and future — C. L. Amick, General Electric Co.
Luncheon and Address by Duncan M. Jones, National President, I.E.S. Introduction by Glenn E. Park, Southern Regional Vice-President.

Afternoon Session

Chairman, G. L. Morris, Alabama Chapter.
Church Lighting — Edward Rambusch, Rambusch Decorating Co.
Lighting Curves — R. D. Bradley, Day-Brite Lighting Inc.
Floodlighting — Wally Weld, Revere Electric Mfg. Co.
Question and Answer Period.
Cocktail Party.

Friday, April 1

Morning Session

Chairman—Roy E. Hallman, Palmetto Chapter.
Industrial and Commercial Lighting — Hugh Nazor, Smithcraft Lighting Division.
Street Lighting — W. Longmuir, General Electric Co. Apparatus Div.
Question and Answer Period.
Luncheon and Address by William Clapp, President, Florida Power Corp.

Afternoon Session

Chairman — Jim Lowe, Tar-Heel Section.
My Most Interesting Lighting Job Contest.
Lighting Forum — All Speakers.
Closing Talk by National President.
Acknowledgments by Conference Chairman.
Banquet and Awards for Lighting Contest Winners, awards made by National President.

Committees

The Conference was under the general direction of G. N. Jack of Florida Section, with the following assists:

Glenn E. Park ..... Southern Regional V-P
Papers & Program ..... Frank Moos
Finance ..... C. E. "Doc" McCormick
Publicity & Attendance ..... A. D. Wallace
Hotel Arrange. & Reception ..... Barney Best
Entertainment & Transp. ..... Ray Simmons

Snapped at the Southern Regional: l. to r., Edward Rambusch; Frank Moos, Chairman Florida Section; Duncan M. Jones, IES President, and George Jack, Conference Chairman.

Reports on the Regional Conferences in the Pacific Northwest Region, at Harrison Hot Springs, B. C.; in the Canadian Region, at Montreal, Que.; and in the East Central Region, at Reading, Pa. will appear in the July issue of IE.

Technical session at the Southwestern Regional Conference.

Southwestern Regional Conference Held in San Antonio, Texas

The Southwestern Regional Conference, chronologically the second in this year's series, was second to none in quality of technical program, entertainment and social events, and local color. With the Alamo Chapter as host, the Conference was held at the Gunter Hotel, San Antonio, Texas, April 3 through April 5, with a registration of 139 members and guests.

President Duncan Jones and Mrs. Jones were, of course, the guests of honor, and upon their arrival were entertained at an informal brunch held in the garden of the home of T. R. Halsey, Conference Chairman, and Mrs. Halsey. Also at the luncheon were Floyd A. Covington, Jr., Chairman of the Alamo Chapter, and Robert G. Turpin, Publicity and Attendance Chairman, with Mrs. Covington and Mrs. Turpin.

A Local Activities meeting, held Sunday afternoon, proved of interest to the officers, managers and members of the Region's Sections, Chapters and Study Clubs. Regional Vice-President M. J. Myers presided.

The President's Reception, Sunday evening, afforded members of the Region an opportunity to meet the guests of honor, Mr. and Mrs. Jones, as well as other out-of-Region guests — and each other.

Technical Program

A complete listing of the technical papers presented at the Southwestern Regional can be found near the end of this report. Suffice it to say here that the four well-attended sessions featured distinguished speakers, both local and imported; that the ever-popular Progress Report, presented by Gene Beggs of Westinghouse, Bloomfield, was interesting and informative; AND that the contest for My Most Interesting Lighting Job was won by Messrs. Floyd A. Covington, Sr. and Jr., who entered the contest jointly with an excellent lighting treatment of the McNay Art Museum in San Antonio.

A luncheon meeting between the two technical sessions on Tuesday, April 5, was held with the National Electrical Contractors Association and the Independent Electrical Contractors Association. William G. Darley, Engineer in San Antonio presided at this meeting, and IES President Duncan Jones gave the address.

For the Ladies and "Off-Duty" Delegates

For the ladies, while husbands were attending technical sessions, a program of social events included a shopping tour in Downtown San Antonio, luncheon at Casa Rio in the atmosphere of Old Mexico, a sight-seeing tour of the city, and a luncheon and style show at the Seven Oaks Country Club. Delegates and wives joined for the President's Reception and Cocktail Party, which was held the opening evening.

A dinner dance — Texas-style, complete with barbecue — was held Monday evening at the Pearl Corral. Entertainment consisted of dancing and a presentation of typical Latin-American dances and songs in costume by local professional talent. Highlight of the evening was the presentation by the Alamo Chapter, Conference hosts, to Mr. Jones of a Texas Stetson hat and a cowboy shirt. Mrs. Jones was presented with a rebozo (stole) from Guatemala.

Program of Papers

After registration, the Conference was opened by M. J. Myers, Regional V-P.

VIP's in San Antonio: left to right, Floyd A. Covington, Jr., Chairman of the Alamo Chapter; IES National President Duncan Jones; T. R. Halsey, Chairman of the Southwestern Regional Conference; M. J. Myers, Jr., Southwestern Regional Vice-President.

Between papers at a technical session, Miss Ruth Patterson, Lighting Engineer at Dallas Power and Light Co., chats with President Jones.

Happy group at the President's Reception is composed of Floyd A. Covington, Sr., Floyd A. Covington, Jr., Mrs. Jones, President Jones and Conference Chairman T. R. Halsey.

The delegates were greeted by Vic Brannig, General Manager, City Public Service Board. The program of papers was as follows:

April 4 — Morning

Chairman — H. D. Weisser

General Electric Co.

Chairman of the San Jacinto Section

Lighting the Outdoors — Sports and Street Lighting — Kirk M. Reid, General Electric Co.

Dimming of Fluorescent Lamps — William B. Carpenter, Superior Electric Co.

Luncheon — Floyd A. Covington, Jr., Chairman.

Society Report — Duncan M. Jones, President, IES.

April 4 — Afternoon

Chairman — John G. Felton

Sylvania Electric Products, Inc.

Chairman, Southwestern Section

Color and Lighting — W. J. Robbins, Pittsburgh Plate Glass Co.

Planning for a Maintenance Program — T. C. Sargent, Sylvania Electric Products, Inc.

Trends in Power Systems for Lighting.

1. Power System Design — H. N. Hickok, Application Engineer, General Electric Co.
2. Lighting Panels and Circuit Devices — R. W. Morefield, Distribution Assemblies Division, General Electric Co.
3. Control of High Voltage Circuits — T. G. Huttlemeier, Construction Materials Division, General Electric Co.
4. Lighting System Study for a Modern Office Building — W. W. Henderson, Bernard Johnson & Associates.

April 5 — Morning

Chairman — W. E. Short

Consulting Engineer, Tulsa, Okla.

Chairman, Oil Capitol Chapter

What Lighting Can Do for Architecture — Henry Walther, Architect, Weidner and Walther.

Lighting Progress Report — E. W. Beggs, Westinghouse Electric Corp., Lamp Division.

Luncheon — Joint meeting with NECA and IECA — Chairman, William G. Darley, Engineer, San Antonio.

Address — Duncan Jones, President IES.

(Continued on page 15A)

Brunch in the garden of the T. R. Halsey home. Left to right are Mrs. R. G. Turpin, T. R. Halsey, President D. M. Jones, Mrs. T. R. Halsey, Mrs. Floyd A. Covington, Jr., Floyd Covington, Jr., and Mrs. Jones. Empty seat at end of table belongs to photographer pro tem, R. G. Turpin, Publicity and Attendance Chairman of the Conference.

At the President's Reception, Hotel Gunter are: Mrs. Jack Faglie, Chairman, Ladies Entertainment; President Jones, and Mrs. T. R. Halsey.

INTENSITY IN MAIN THOROUGHFARES of Chicago's Grant Park Underground Garage is specified at 22 foot candles. This Sola Constant Wattage-Ballasted fluorescent lighting installation delivers that specified level 24 hours a day. Solar Light Manufacturing Company, Chicago, is lighting fixture manufacturer; J. Livingston & Company, electrical installations; John Griffiths & Son Construction Co., general contractor, and Ralph H. Burke, Inc., consulting engineers.

Sola Constant Wattage Ballasts Light World's Largest Underground Garage

Chicago's Grant Park Garage — the world's largest underground — holds 2,359 cars on its 787,000 square feet of floor space. Since 90% of the cars are owner-parked, high quality lighting 24 hours a day is a safety "must".

This ultra-modern garage is illuminated by a rapid-start lighting system specially designed for operation under a wide range of ambient temperatures. Sola Constant Wattage Ballasts are installed in the fixtures to provide dependable lamp operation under this severe operating condition. Their patented constant-wattage circuit, assures these operating efficiencies:

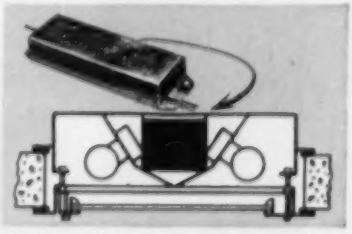
LONG LAMP LIFE: Lamp life is inversely proportional to the peak/rms ratio of the lamp's current wave shape. Sola ballasts' peak/rms ratio is approximately 1.5 @ 118v — extremely low with good wave shape — resulting in long lamp life. In any large installation like the Grant Park Garage, minimum lamp maintenance is important.

CONSTANT LIGHT OUTPUT: Lumen output is held constant to within ±2% over a primary range of 106-130v — delivers all the light paid for, regardless of line voltage changes up to 20%.

LONG BALLAST LIFE: Temperature rise is low under normal operation. When one or both lamps fail, ballast operating temperature is reduced, not increased. This yields long ballast life by sharply reducing ballast failures due to abnormal heat rise.

If you manufacture fixtures, or if you specify, operate or maintain lighting installations, investigate the advantages of a Sola Constant Wattage Ballasted rapid-start system. The same efficiency of operation found in the Grant Park Garage installation can be part of your lighting system.

SOLA-BALLASTED TWO-LAMP COVE UNITS provide safe illumination for exit and entrance ramps. Other specified levels of illumination are: distribution center, 30 foot candles; and parking area, 10 foot candles (average).



CROSS-SECTION OF RECESSED TROFFER FIXTURES (installed in main thoroughfares) shows two-lamp Sola ballast installation method.

SOLA *Constant Wattage* **BALLASTS**

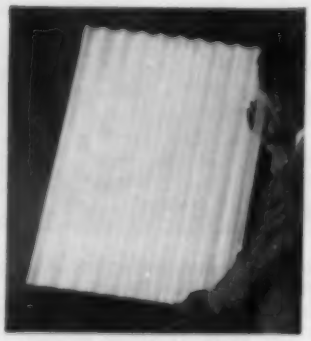
Write for Bulletin 3 F-FL-199 describing standard Constant Wattage Rapid Start Ballasts; or request a call from a Sola Sales Engineer to discuss special application problems such as this garage.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3356 CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4282 • TORONTO 9, ONTARIO: 617 Runnymede Rd., Lyndhurst 1654 • Representatives in Other Principal Cities

Sheeting of extruded "Lucite" acrylic resin is available in a variety of clear and translucent colors from custom extruders. Extruded troffer-type panels of "Lucite" transmit optimum light without glare.

Lighting as a design element

Specify extruded Du Pont LUCITE® acrylic resin for well-engineered lighting effects



Extruded panels of "Lucite" like this are used for light-diffusing ceilings. "Lucite" has excellent impact strength and color stability. Its light transmission does not deteriorate with time.

Luminous panels and sheeting of "Lucite" can be fabricated in an unlimited number of designs of unusual beauty. Panels of "Lucite" can be extruded in widths up to 4 feet—and in a variety of diffusing, clear and translucent colors. Extruded sheets of "Lucite"—flat, formed or corrugated—make unique light-diffusing ceilings.

"Lucite" is highly resistant to shattering and weathering. This engineering material used in lenses and panels efficiently transmits light without glare. Fabrication is economical to custom specifications. Fixtures of "Lucite" retain their initial uniform color and appearance with minimum cleaning.

Write to the E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 286 Du Pont Building, Wilmington 98, Delaware, for complete information on extruded "Lucite" now available for engineered lighting.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

(Continued from page 12A)

April 5 — Afternoon

Chairman — Ruben K. Lothrop,

Southwestern Gas and Electric Co.

Past-Chairman, Ark-La-Tex Chapter

Luminous Panel Lighting — Benjamin S. Benson, Jr., Benjamin Electric Mfg. Co.
My Most Interesting Lighting Job Contest.
Adjournment.

WHERE CREDIT IS DUE

Committee Chairmen and Section and Chapter Officers on whom credit should be bestowed are:

CONFERENCE COMMITTEE

General Conference Chairman .... T. R. Halsey
Finance ..... Douglas Hileman
Papers and Program ..... Floyd A. Covington, William G. Darley
Attendance and Publicity ..... R. G. Turpin
Hotel ..... Gordon Brown
Registration and Reception .. Ted C. Telotte, Jr.
Transportation ..... George Davis
Entertainment ..... James R. Jones
Ladies Entertainment .. Mr. & Mrs. Jack Faglie

SECTION AND CHAPTER OFFICERS

SOUTHWESTERN SECTION

Chairman ..... John G. Felton
Secretary ..... John B. Deck

SAN JACINTO SECTION

Chairman ..... H. D. Weisser
Secretary ..... V. P. Flynn

ALAMO CHAPTER

Chairman ..... Floyd A. Covington, Jr.
Secretary ..... Milton Uhr

OKLAHOMA CHAPTER

Chairman ..... W. T. Short
Secretary ..... F. Allen Whiteside

ARK-LA-TEX CHAPTER

Chairman ..... J. G. Harriss, Jr.
Secretary ..... C. R. Shepherd

National Council Meeting Feature of Inter-Mountain Regional Conference

The far-flung nature of I.E.S. was emphasized in the April 13 meeting of Council. Members and staff traveled to Phoenix, Arizona for the meeting, joining there with western members, and delegates to the Inter-Mountain Regional Conference at the Westward-Ho Hotel. History-making though it was, a Council so far from home base, it was by no means the main event.

To the regional conference format, Phoenix folk managed to apply a characteristic western verve. Result: Several refreshing departures in the technical program offered; definite "take-home" advantages to those attending. Outstanding in that category was the Lighting Fixtures and Fire Rating panel manned by Fire Rating Bureau personnel, building inspector, architect, consulting engineer and lighting engineer. Some candid but useful discussions developed with regard to the installation of such lighting systems as luminous and louverall ceilings, recessed equipment etc. The forum-type discussion disclosed some very interesting points in what to check with local Fire Rating Bureaus in the planning of such systems. Stressed especially was the advisability of consultation with local jurisdiction for all such systems, regardless of UL approvals, if any.

Professor Krachenbuehl, in his talk Tuesday morning raised the morale of lighting men whose knowledge of calculus is rocky (or non-existant). He took the scare clean out of the chief formulae for illumination calculations, breaking them down on a blackboard into good common sense, dissecting several white towers brick by brick. If all present didn't go home with a better understanding of mathematics, they were at least relieved of that sense of guilt at not knowing what the physicists are talking about. His humor defies reporting, but the consensus was that no student ever slept through a Krachenbuehl class.

Several further take-home factors were a feature of Bill Cyr's talk "A Home is Not a House," plus some delightful single and double entendre humor. Not to overlook the rest of the excellent program, listed below. Not evident from a mere list, however, are the new gray hairs acquired by Gene Beggs, on hand to present the popular "Progress Report." Some minion of the airlines deflected all his slides and equipment to Albuquerque. He rose above this nightmare situation and did a wonderful job, projecting illustrations from the published report in February IE.

Another plus feature of the Inter-Mountain Regional Conference was the hall in which it was held. Eschewing the hotel, the Conference proper was held at the Phoenix Library Auditorium, a very superior area having modern arrangements for slide projection, and lighting a good deal better than I.E.S. meetings are used to encountering. Conference Chairman was J. D. Whitnell, currently nominee for Regional Vice-President; Keynote address was by Frank G. Murphy, Mayor of Phoenix whose interest and appreciation of I.E.S. had been sparked by Phoenix' own street lighting program. Registration for the conference was about 150.

LIGHTING CONTEST

The unselfconscious perfection of the western approach was evidently in the MMILJ contest. This was quite obviously handled as a regional project of major importance, headed by the ablest man available, and organized with serious attention to details. This approach paid off in an outstanding program. One item worth copying elsewhere was the excellent pre-contest talk given by the Contest Chairman (John Allen Ware) in which he outlined the value of the contest. Judges at Phoenix were: I.E.S. President Duncan Jones, Leonard Hobbs, Prof. Khachenbuehl, E. F. Lowry and

(Continued on page 16A)

Photo courtesy *Electrical West*

Lighting Fixture and Fire Rating Panel highlighted the excellent technical program offered at Phoenix. Answering questions raised were: l. to r., F. C. Jones, H. H. Dinwiddie, L. LeRaine, J. G. Platt, Bevan Jones, Moderator of the session.

Eastern members basked in Arizona climate at every opportunity. Shown at coffee break: A. D. Hinckley, J. H. McCulloch, George Setter, E. C. Dunn. Photographer, also an easterner, obviously not accustomed to intense sunshine.

MMILJ Contest winners were: Charles Bell, proxy for Southern Colorado Chapter (third prize); Ferman Bischofberger, proxy for Rocky Mountain Section (second); David Demaree, Arizona Section, top winner in the Region.

(Continued from page 15A)

Ruby Redford, who judged the following installations:

First Prize — David Demaree, Arizona Section. Holbrook High School Gymnasium.

Second Prize — L. M. Bailey and Ellis Gilchrist, Rocky Mountain Section. State Capitol Building in Denver. (Ferman Bischofberger served as their proxy.)

Third Prize — Miss A. D. Berry, Southern Colorado Chapter. Trott Residence, Canyon City, Colo. (Charles Bell was proxy for Miss Berry.)

Regional Activities

Eighteen incoming and retiring local officers, with national officers and headquarters staff convened April 12 for a Regional Activities luncheon at the Arizona Club, as guests of the Newbery Electric Corp., Phoenix. A number of items of importance to future operation came up for discussion. A common problem was apparently the development of interesting local programs. Discussion at the luncheon promoted a helpful arrangement of inter-Section cooperation on the subject of visiting speakers. Other matters thrashed out included special plans for programs aimed at the interests of electrical contractors, architects and young people. Discussion disclosed that the best spurts in new membership came from such local projects as study clubs, illumination courses and similar educational activities. Still further growth in this Region was indicated by reports that Chapters are aforming in El Paso, Boise, Idaho, and (just outside the Region) Butte, Montana.

Dates were set for future Regional Conferences, next year's to be April 26-28 in Salt Lake City. A successful bid for 1957 was made by the New Mexico Chapter, with Albuquerque the locale.

G. F. Buck, Regional Vice-President presided at the meeting, aided by Ray Jonas of Newbery Electric Corp., Chairman of the Arizona Section.

Social

Theoretically the social program at a Regional Conference is designed for visiting wives. Let it not be said, however, that the men didn't have fun too. The

(Continued on page 18A)

Regional Activities Luncheon, shown at the Arizona Club, was attended by 18 local and national officers of I.E.S. and headquarters staff. Host for this meeting was the Newbury Electric Corp.

Top speakers on the Inter-Mountain Regional program included Prof. Dan Finch, Prof. John Kraehenbuehl and William A. Cyr, Associate Editor of *Electrical West*.

the new smithcraft troffer is

RECESSED LIGHTING AT ITS BEST

in clean, trim appearance . . . and in mechanics, too!

Twelve important features of the new Smithcraft Troffer illustrate the completeness of design development that went into this new outstanding recessed lighting. Important among the twelve features for architects and engineers is the fact that they can now create absolutely clean, trim, architectural lighting effects without the disturbing blemishes caused by exposed hinges, locks, fasteners or screws. The ceiling is uncluttered . . . the final lighting effect is crisp, modern and efficient.

The new line of Smithcraft Troffers is truly complete, offering troffers with or without integral trim flange, with the widest choice of shielding media and adaptable to virtually any ceiling construction.

Specify Smithcraft for superior appearance, unsurpassed lighting performance together with ease and economy of installation.

Complete details are offered on the new Smithcraft 12" wide troffers. This new Smithcraft Troffer book also gives complete information on the new Smithcraft line of 2-foot wide troffers — available with many types of shielding media and for many different types of ceiling construction.

1. No visible catches, latches, hinges, bolts or screws.
2. Door frame containing glass, lens or plastic opens or closes by simple pressure upwards with the new exclusive Smithcraft Pressure-Catch. (Patents pending). To remove, door-frame simply lift off without tools or loose parts.
3. In louvered units, louvers hinge from either side, close by simple pressure upwards, and are removed without tools or loose parts. (Patent #2,559,640)
4. Architecturally precise modules for exactly 12" openings — perfectly straight, trim, in-line rows, whether mounted individually or in continuous rows.
5. No light leaks.
6. Slimly-designed glass frame for better appearance and better efficiency.
7. Wide selection of shielding media, spot baffles, pattern lighting, etc., for flexibility of design.
8. Troffers are available with integral trim flange for finishing the ceiling opening, if required.
9. Adaptability to today's ceilings is virtually universal. Simple clips adapt troffer to all of today's most common ceilings; simple provision for adaptability to all others. The new Smithcraft Troffer-in-plaster frame method assures perfectly square openings.
10. From start to finish only tool required is a screwdriver.
11. No exact positioning required, maximum simple adjustability at every critical point, with the Smithcraft Yoke-Aligner Hanger (Patent #2,597,875, other patents pending)
12. Minimum number of parts and assembly on the job.

Smithcraft LIGHTING DIVISION, CHELSEA 50, MASS. *America's finest recessed lighting*

Banquet honoring President Duncan Jones was a happy highlight of the social program.

Judges for the MMILJ Contest in close debate: l. to r., Duncan Jones, Leonard Hobbs, Stanley Bazant (Teller), John Kraehenbuehl, E. F. Lowry. Also a judge, but behind the camera, Ruby Redford.

Representatives from each of the Sections and Chapters of the Inter-Mountain Region served as chairmen of the five technical sessions. L. to r., Marvin Dancie, Utah Section; Stan Bazant, New Mexico Chapter; Glen B. Gaer, Rocky Mountain Section; Ray Jonas, Arizona Section; Charles Bell, Southern Colorado Chapter.

(Continued from page 16A)

eastern visitors especially, agog at a climate having three per cent humidity and perpetual sunshine, indulged themselves with this phenomenon at every free moment. Specially for the ladies, however, was a sight-seeing trip across the desert to Scottsdale, the "West's Most Western Town." This unique community has an ordinance requiring that every building be built to the style of the old west, with a rather fascinating result. Also part of the ladies program was a luncheon with style show, the following day. The ladies stayed on after lunch for a bridge and canasta party, and a swimming party at the lovely outdoor pool of the Westward-Ho Hotel.

A reception and cocktail party were held the first evening of the conference on the hotel roof-garden involving all present. The final evening featured a banquet honoring President Jones. During the festivities, President Jones was presented with a Western tooled-leather belt, a gift from the Region.

Papers Program

For the record, the entire program of the 1955 Inter-Mountain Regional Conference is listed below:

General Session

April 11

Conference Opening and Introduction of National Officers, I.E.S.
J. D. Whitnell, Conference Chairman

Welcome to Phoenix — Frank G. Murphy, Mayor, City of Phoenix.

Response — Roy Jonas, Chairman, Arizona Section, I.E.S.

Introduction of Duncan Jones, President of I.E.S. — by G. B. Buck II, Inter-Mountain Regional Vice-President.

President's Message — Duncan M. Jones, President of I.E.S.

Intermission.

(Continued on page 21A)

. . . another advance in mercury lighting from G. E.

Now 54% more light from G-E 400-watt mercury lamp

New General Electric H400-RC1 gives top color balance, too

In another mercury lighting first, General Electric has raised the light output of the H400-RC1 mercury lamp from 12,300 to 19,000 lumens! This 54% increase in efficiency results from using a special fluorescent phosphor as a reflector as well as to improve color balance. Its color characteristics are best of any mercury lamp for general lighting. Color rendition approximates a mixture of ⅓ filament light and ⅔ mercury light.

The new G-E H400-RC1 mercury lamp has a life rating of 6000 hours at 5 or more hours per start. It operates on the same equipment as all other 400-watt mercury lamps and is interchangeable in most reflectors.

With its controlled beam, good color, easy maintenance, and high light output, it is first choice for most mercury lighting applications.

For more information on how this new mercury lamp can fit your operation, call your G-E Lamp supplier, or write General Electric Company, Lamp Division, Dept. 482-IE-6, Nela Park, Cleveland 12, Ohio.

COMPARE NEW G-E RC1 WITH OTHER 400-WATT MERCURY TYPES

NEW RC1 VS H400-E1

- Light on the work equal or greater in most equipment
- Adds color balance
- Less maintenance

NEW RC1 VS H400-J1

- Delivers 10-20% more light on the work in most equipment
- Has somewhat better color balance
- Lower cost of light

NEW RC1 VS H400-A1

- 35% more light on the work in most equipment
- Has good color balance
- Lower cost of light

Progress Is Our Most Important Product

GENERAL ELECTRIC

Main control room, Receiving Station G, Department of Water and Power of the City of Los Angeles. White translucent diffusers are fire-retardant PLEXIGLAS 5009. Panels measure 2' by 4', are dimple-patterned.

Where the task is exacting——

use PLEXIGLAS diffusers

This control room requires lighting of the highest quality, because the seeing tasks involved in the constant reading of instruments and keeping of records are complex and exacting.

Diffusing panels of PLEXIGLAS® acrylic plastic are an important part of the carefully engineered lighting system that produces the desired results. Light is spread evenly across the entire surface of each diffuser. The illumination level is high; surface brightness, and brightness ratios throughout the room, are low. There is a notable absence of shadows and reflected glare.

In addition to its superiority in the diffusion and transmission of light, PLEXIGLAS is rigid, strong and durable. It has exceptional freedom from discoloration on long exposure to fluorescent lamps. Lighting systems incorporating PLEXIGLAS retain their efficiency and new appearance for many years.

We will be glad to send you details about the installation shown above.

Canadian distributor: Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

(*Continued from page 18A*)

Technical Session No. 1

April 11

Presiding — Glenn B. Gaer, Chairman-Elect, Rocky Mountain Section

My Most Interesting Lighting Job—John Allen Ware, Jr., John Allen Ware and Asociates, Phoenix, Arizona; John B. Thompson, Grayco Products, Phoenix, Arizona, Co-chairmen.

A Home is Not a House — Wm. Cyr, *Electric West*, San Francis o, Calif.

Lunch.

Technical Session No. 2

April 11

Presiding — Marvin E. Dansie, Chairman Utah Section

Presentation of Awards for Most Interesting Lighting Job Contest—G. B. Buck II, Intermountain Regional Vice-President.

The Fluorescent Lamp—Yesterday, Today, and Tomorrow — Erwin F. Lowry, Mgr., Engineering Laboratories, Sylvania Electric Products, Salem, Massachusetts.

Incandescent Lamp Progress—Kirk Reid, General Electric Lamp Division, Nela Park, Ohio.

Intermission.

Cold Cathode Lamp Characteristics — Abner A. Byer, President, Co'd Cathode Lighting Corp., Long Island City, N. Y.

Progress Report — E. W. Beggs, Westinghouse Electric Corp., Bloomfield, N. J.

Lighting and Power Generation — Henry B. Sargent, President, Arizona Public Service Co., Phoenix, Ariz.

Adjourn.

Technical Session No. 3

April 12

Presiding — G. R. Gardner, Chairman New Mexico Chapter

Relighting the Denver Schools — F. Bischofberger, Colorado Public Service Co., Denver, Colo.

A Simplified Method for Determining Illumination from Point and Surface Sources — Dr. John O. Kraehenbuehl, University of Illinois, Champaigne, Ill.

Intermission.

Education and Illumination—Dr. D. M. Finch, Dept. of Electrical Engineering, University of California, Berkeley, Calif.

Lighting Fixtures and Fire Rating (panel)

Moderator—Bevan Jones, Sales Consultant, Arizona Public Service Co., Phoenix, Ariz.

Panel Members—Lloyd LeRaine Pike, A.I.A. Architect, Phoenix, Ariz.: H. H. Dinwiddie, Building Inspector II, City of Phoenix, Ariz.; Frank C. Jones, Arizona Fire Rating Bureau, Phoenix, Ariz.; J. G. Platt, Sales Engineer, Holophane, Inc., Los Angeles, Calif.

Lunch.

Technical Session No. 4

April 12

Presiding — Clarence F. Hoer, Chairman Southern Colorado Chapter

Street Lighting in the City of Phoenix — D. B. Johnson, Street Light Engineer, Arizona Public Service Co., Phoenix; Glenn Kiger, City Electrician, City of Phoenix.

The Importance of Auxiliary Equipment — J. Hugh McCulloch, General Electric Apparatus Div., Danville, Ohio.

Residential Lighting and Residential Architecture — F. Guirey, A.I.A. Architect, Phoenix, Ariz.

Intermission.

Luminous Ceilings — David B. Bluford, Vice-President of Sales, Luminous Ceilings, Inc., Chicago, Ill.

Lighting and Power Factor — C. Mobley, Sales Engineer, Tucson Gas and Electric Co., Tucson, Ariz.

The Light of Your Life — G. B. Buck II, General Electric Lamp Division, Denver, Colo.

Announcements and Close.

J. D. Whitnell, Conference Chairman.

Adjourn.

CREDIT DUE

All members of the Arizona Section were ex-officio committeemen and wore their regular Section badges to identify themselves for any services needed. More specific responsibility, however, was assumed by the following for this successful meeting.

G. B. Buck II — Regional Vice-President

ARIZONA SECTION

Chairman ..... Ray Jonas
Secretary ..... John Gohring

NEW MEXICO CHAPTER

Chairman ..... G. R. Gardner
Secretary ..... Wm. Hills

ROCKY MOUNTAIN SECTION

Chairman ..... Charles O. Woodworth
Secretary ..... L. J. Carlon

SOUTHERN COLORADO CHAPTER

Chairman ..... Charles F. Hoer
Secretary ..... John H. Rheuff

UTAH SECTION

Chairman ..... Marvin Dansie
Secretary ..... Wayne F. Mulcock

CONFERENCE COMMITTEES

General Conferen e Chairman .. J. D. Whitnell
Vice-Chairman ..... Ray Jonas

CONFERENCE EXECUTIVE COMMITTEE

Regional Vice-President ..... G. B. Buck II
Chairman Arizona Section ..... Ray Jonas
Honorary Vice-Chairman ..... Jack McDonald
Secretary-Treasurer ..... John Gohring

COMMITTEE CHAIRMEN

Program ..... J. D. Whitnell
Papers Committee ..... S. L. Burnham
Attendance and Publicity ..... Wm. Savoy
Transportation and Reservations .. J. R. Byers
Decorations ..... R. Godemann
Registration and Reception ..... T. Buckwell
"Most Interesting Lighting Job"
John Thompson, John A. Ware, Jr.
Entertainment ..... Jack McDonald
Coordinator ..... Bevan Jones

South Pacific Coast Regional Conference
Host to 250 in Los Angeles

Conference Statistics

Time: April 13, 14, 15, 1955
Place: Hotel Statler, Los Angeles, Calif.
Chairman: F. Jack Rohring
Attendance: 250

If it were required to report a west coast Regional Conference in a single word, the best choice would be "professional." Every feature of it shows experience, organization and local respect. Clearly, west coast meetings are events of wide influence. Their programs are apparently patterned purposely to interest and inform other groups, as well as I.E.S. members. In this they succeeded, notably, in the 1955 conference in Los Angeles. A large and seriously interested portion of the audience opening day, was composed of city officials and police for example. Their aim — the authoritative discussion on traffic safety lighting sponsored as part of the conference program.

TRAFFIC SAFETY PANEL

This panel, manned by the men who had the most and the best experience in that field, produced a valuable collection of high level thoughts, useful to any municipal man who was fortunate enough to catch it. Street lighting engineers, law enforcement officers, traffic legislators and automobile manufacturers everywhere, would have been well served to have heard it. Ably kept on the beam by Professor L. M. K. Boelter of U.C.L.A., the traffic safety conference developed a number of subjects which have long been under discussion. Tinted windshield glass, for instance. Tests on this showed varying results, per Dr. Heinz Haber, physicist. Slight reduction of visibility through such glass might be worth the relative reduction of glare in the daytime; at night reduced visibility added to conditions that were critical to start with, though increased illumination on the target may offset this.

Other questions raised: What percentage of the reduction in traffic fatalities in relighted Los Angeles could be attributed to the lighting? Can't be evaluated, said Police Commander H. W. Sullivan, as against other factors, like education, and enforcement. He felt it was an important enough factor in the reduction, however, that all street lighting should be based on safety studies.

How much time does it take to see a traffic direction sign? Dr. G. E. Mount, a psychologist at U.C.L.A. who has studied this question, says that people having to make multiple decisions lose efficiency all round. Signs, even ads, need further attention to alleviate this tendency. Mostly signs should be bigger, and so placed that they tell you what to do, and not what you should have done, too late, he said. There should be more uniformity too, between the several bureaus involved, and there should be laws to back up state standards and policies on sign size. Dr. Heinz Haber discussed how designers of vehicles can improve the ability to see in the highway, especially in connection with glare reduction. Dr. Henry A. Knoll, Dean of the Los Angeles College of Optometry advocated bigger signs with higher contrasts and possibly horizontal lighting. He demonstrated a table showing how long it takes to recognize various traffic signs.

Can we have trees and street lighting

(*Continued on page 22A*)

Cleveland National Conference is promoted by Edwin Blair, left, Chairman of the Southern California Section, and by Kirk Reid, of Cleveland, holding the banner, "Cleveland Invites You in '55."

Photos courtesy W. A. Cyr, *Electrical West*

Canadian Consul-General, Mr. Leslie Chance (right) was a guest at the Los Angeles banquet, introducing the Society's first Canadian President, Duncan M. Jones, shown addressing the audience.

(Continued from page 21A)

too? Kirk Reid of General Electric discussed this, as well as the conflict between street lighting and other surround objects (posters, show windows etc.). These can be and often are traffic hazards and he advocated I.E.S. study on the proper design to eliminate bad features. He showed slides of the type of trees which could be planted for a safe compromise between civic beauty and safe street lighting.

Other very pertinent discussions by the panel included: Brightness relationship for night driving by Prof. D. M. Finch of the University of California. Studies on how lighting related to the movement of cars and people, by J. E. Havenner, Auto Club of Southern California. Continuous vs. intermittent roadway lighting by A. T. Nadeau, Los Angeles Bureau of Street Lighting. New types of lighting devices, by G. A. Trosper, Pacific Gas and Electric Co., San Francisco.

Several other panel discussions were featured at later sessions. Of special interest were symposiums on Light Sources, led by Kirk Reid, Industrial Lighting under the direction of Ben Benson; Floodlighting led by T. H. Shepherd, and Office Lighting with John J. Neidhart as panel leader. Messrs. Benson, Reid and Neidhart were not the only speakers from far away. Program Chairman Roy Jones, himself newly transferred from the east, had also included Eastern experts E. H. Salter of E.T.L., New York City; Dr. E. F. Lowry, Sylvania, Salem, Mass. and Eugene W. Beggs, Westinghouse, Bloomfield, N. J. In addition to participating in the Light Sources panel, Mr. Beggs also presented the Lighting Progress Report as the opening session Wednesday evening. All details of the excellent program are shown in the list at the end of this report.

Photo courtesy William A. Cyr, *Electrical West*

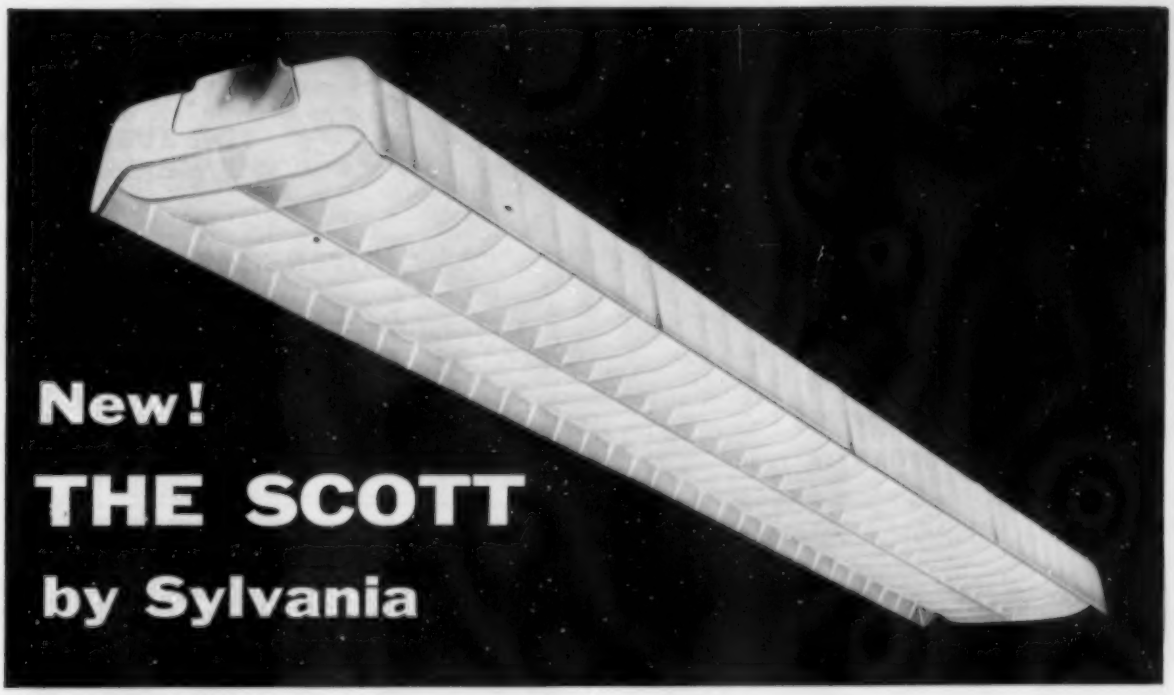
My Most Interesting Lighting Job Contest entrants snapped at the Conference. L. to r., Harold Strahn, Contest Chairman; Gordon Dovey, Southern California Section, first prize; Sydney Furniss of San Diego Chapter, third; F. H. Logan, Northern California Section, second place.

M.M.I.L.J.

As with other Regional Conferences, a popular session at the South Pacific meeting was the I.E.S. contest for "My Most Interesting Lighting Job." Also in common with other successful contests, this one had been under the direction of a competent chairman, right from the beginning. Chairman for the Los Angeles conference was Harold Strahn, Los Angeles Department of Water and Power. Judges were appointed from among out-of-town experts: Ben Benson of Benjamin Electric Mfg. Co., Des Plaines, Illinois; Gene Beggs, Westinghouse, Bloomfield, N. J.; Dr. E. F. Lowry, Sylvania, Salem, Mass. Their judgment resulted in the following:

First Prize — Southern California Section, Gordon L. Dovey, "Lighting a Ball-Point Pen Factory."

(Continued on page 25A)



Solves many school lighting problems

...at low cost!

INTRODUCING THE SCOTT, Sylvania's leader in an entirely new trend in lighting! Here's a new low-brightness fluorescent fixture with an all-luminous, all-plastic shielding, providing an over-all illumination efficiency of 89.8%.

Combine the efficiency of *The Scott* with its ease of installation and maintenance, and you have a fixture that goes a long way toward answering today's problems of rising costs. Check these unique features:

Top Efficiency, Low Brightness—89.8% efficiency provides more light with fewer fixtures. Low brightness substantially reduces glare and eyestrain.

All-Luminous Appearance—All-plastic shielding diffuses comfortable light to all corners of a room.

Exciting Design Advance—Exclusive modern design, clean lines blend with up-to-date classroom décor.

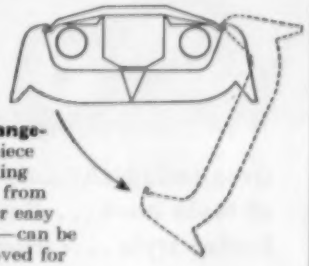
Lightweight, Rigid Construction—Plastic shielding alleviates critical weight factor, holds straight-line characteristics.

For unusual effects, colored lamps may be used. For complete specifications and information, write for our Booklet F-612. *You incur no obligation.*

SYLVANIA ELECTRIC PRODUCTS, INC.
60 Boston St., Salem, Mass.

SYLVANIA®

...fastest growing name in sight



Convenient Hinging Arrangement. One-piece plastic shielding swings down from either side for easy maintenance—can be quickly removed for cleaning.

Specify these features . . . specify THE SCOTT

1. One-piece, all-plastic louver shielding.
2. Plastic shielding of high-temperature, destaticized polystyrene.
3. Minimum 35° lengthwise and 35° crosswise shielding.
4. Efficiency of 89.8% with an ICI distribution of 55% up and 45% down.
5. Shielding hinged or removed from either side.
6. Silver-plated lampholder contacts on rapid start fixtures.
7. Channel blanked from 18-gauge cold rolled steel with longitudinal forming.
8. All painted metal parts subjected to the patented #160 Bonderite Process *after* fabrication.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

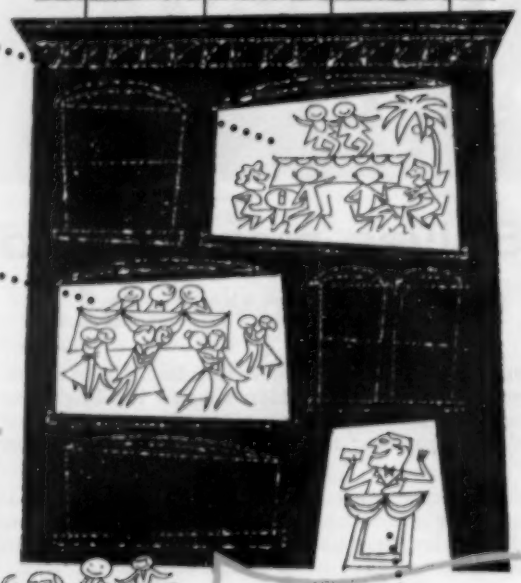
THERE'S *Entertainment* FOR EVERYONE

AT THE 1955 I.E.S. TECHNICAL CONFERENCE

CLEVELAND'S
Hotel Statler
September 12-16

Monday Night
I.E.S. FUTURAMA featuring skits by various sections in a nightclub atmosphere...

Thursday Night
President's Reception and **Banquet** followed by dancing...



Wednesday Night
Gala INTERNATIONAL PARTY at Nela Park... dinner served buffet style... entertainment by Cleveland's outstanding Nationality Groups...
Come dressed in your favorite nationality costume.

INFORMATION
and travel arrangements for International Party at Nela Park

It's easy to see that the committees have gone all out to make the '55 I.E.S. Technical Conference the best ever . . . a well-rounded technical program covering subjects of interest to every member... entertainment devised to suit every taste . . . and a full program of activities arranged for the ladies. Decide now not to miss this conference week. You'll be glad you decided to come to Cleveland in September!

make your plans, now!

Seen at the President's Reception

Statler Hotel
Los Angeles

Jerry Whitnell from Phoenix, Arizona chats with Kirk Reid. They are, respectively incoming Regional V-P for Inter-Mountain and National Vice-President.

Ben J. Hartman of Los Angeles with Mr. and Mrs. C. W. McCormick. He's Regional Vice-President of the Northeastern Region, and from Hartford, Conn.

John Neidhart, Roy and Mrs. Jones, the Gene Beggs' (at this point veterans of three I.E.S. Regional Conferences) and the Duncan Jones' (likewise).

L. H. Graves (Past-President of I.E.S.) and Mrs. Graves with President Duncan M. Jones.

(Continued from page 22A)

SECOND — Northern California Section, F. H. Logan, "Daylighting for a School."

THIRD — San Diego Chapter, S. A. Furniss, "Lighting El Cortez Ballroom."

JUST FOR FUN

In the best Convention tradition, the delegates to the South Pacific Regional Conference stuck strictly to business all day long, but relaxed in one wonderful swoop at the President's Banquet. This was a brilliant social affair, followed by a dance. Regional Vice-President Dan M. Finch presided over a popular session which included no speeches. President and Mrs. Jones were presented with a clock-radio as a gift from the Region and memento of west coast hospitality. An impressive touch at the Banquet was the presence of the Canadian Consul General, Mr. Leslie Chance, who introduced President Jones, the Society's first Canadian President.

An additional special social program, however, was arranged for the visiting wives. This was under the direction of Mrs. Roy H. Kreyser and was a huge success. The women started getting acquainted Wednesday afternoon at a bridge and canasta party at the Statler, and were old friends by the time they attended a shopping tour next morning. They went to a fashion show at I. Magnin's in Pasadena that day too, and had their own social hour in the Sierra Room, just before going to the President's Ball. On the final day Mrs. Kreyser took them to CBS Television City to see two popular shows televised, and then to luncheon at the Farmer's Market, a fabulous California landmark. The sun shone as frequently advertised, and the equally celebrated smog did not develop during the entire Conference.

TECHNICAL PROGRAM

The program, in detail, included the following:

Wednesday Evening — April 13

Chairman: Edwin Blair

Chairman, Southern California Section

Call to Order — F. Jack Rohring, Conference General Chairman.
Address of Welcome — E. W. Biscailuz, Sheriff of Los Angeles County.
Progress Report—E. W. Beggs, Westinghouse Lighting Specialist, Bloomfield, N. J.

(Continued on page 27A)

This G-E development engineer is testing a ballast design for a new fluorescent application. He's a member of the largest ballast development group in the industry. The fundamental research which they perform is one important reason why G.E. is the leading supplier of fluorescent ballasts.

Flora* shows you how . . .

General Electric Ballast Design Leadership Helps You Save Lighting Dollars

General Electric's design leadership has contributed greatly to the vast fund of knowledge now available and being used by the entire ballast industry.

A recognized pioneer in ballast design, G.E. has led in these important developments: Tulamp lead-lag, certified series 96T12, trigger start, rapid start, clamped core, plastic sign, and dimming ballasts. G.E. emphasizes product leadership to provide the best ballast value to the user. We have never resorted to the temptation of lowering product quality to gain competitive advantage. Instead, we furnish only the best ballasts to assure economical fluorescent lighting. We're convinced there is no substitute for satisfactory performance.

To be sure of top quality ballasts with the latest design developments, look to the leader . . . General Electric!

The next time you specify equipment for a fluorescent lighting installation, make sure you get the best . . . specify General Electric ballasts.

A G-E ballast tag or sticker on your fixture is proof that it's equipped with the best in ballast value. It's the only way to be certain. For further information on G-E ballasts, write Section 401-15, General Electric Co., Schenectady 5, New York.

*Miss Fluorescent Ballast, G. E.'s Ballast Mascot

Copyright 1955, General Electric Company

USER SATISFACTION gets foremost consideration by G-E ballast development engineers. Here a ballast is being checked to make sure it will provide optimum light output and lamp life.

Five more reasons why

GENERAL ELECTRIC IS YOUR BEST BALLAST VALUE

- EXCLUSIVE SOUND RATING SYSTEM
- SUPERIOR QUALITY CONTROL
- LONGER BALLAST LIFE
- PRECISE LAMP-MATCHED DESIGN
- COMPLETE CUSTOMER SERVICES

Progress Is Our Most Important Product

GENERAL ELECTRIC

South Pacific Coast Regional Banquet was host to 204 at brilliant social event, April 14, Hotel Statler, Los Angeles.

(Continued from page 25A)

Thursday Morning — April 14

Chairman: James E. Barnes

Chairman, Northern California Section

Points of View on Traffic Safety Lighting — Oscar Meissner, Chairman, City of Los Angeles.
L. M. K. Boelter, Panel Leader, Dean of Engineering, U.C.L.A.
L. M. Braff, General Manager Traffic Department, City of Los Angeles.
D. M. Finch, Department of Engineering, University of California, Berkeley.
Dr. Heinz Haber, Physicist, Institute of Transportation and Engineering, U.C.L.A.
J. E. Havenner, Manager, Public Safety Department, Auto Club of Southern California.
Dr. Henry A. Knoll, Dean of the Los Angeles College of Optometry.
Dr. G. E. Mount, Psychologist, Department of Psychology, U.C.L.A.
A. T. Nadeau, Assistant Director, Bureau of Street Lighting, City of Los Angeles.
Kirk M. Reid, Director, Street Lighting, General Electric Co., Nela Park, Ohio.
H. W. Sullivan, Deputy Chief Commander, Traffic Division, Los Angeles Police Department.
G. A. Trosper, Illuminating Engineer, Pacific Gas & Electric Co., San Francisco.
Honorable Norris Poulson, Mayor of the City of Los Angeles.
Duncan Jones, President of I.E.S.
Light Marches On — Dr. E. F. Lowry, Sylvania Electric Products, Salem, Mass.

Thursday Afternoon

Chairman: William J. Flynn

Chairman, Mother Lode Chapter

The Garden After Twilight — F. B. Nightingale, Kim Lighting Co.
"The Missing Link" — J. C. Meserve, Southern California Edison Co.
My Most Interesting Lighting Job — Harold Strahn, Chairman, Los Angeles Dept. of Water and Power.

Thursday Evening

President's Banquet.

Friday Morning — April 15

ACTIVITIES BREAKFAST

Chairman: J. W. Howard

Chairman, San Diego Chapter

Light Sources
1. Incandescent Lamps — Kirk M. Reid, Panel Leader, General Electric Co., Cleveland, Ohio.
2. Fluorescent Lamps — Roy E. Bevan, Sylvania Electric Products.
3. Mercury Lamps — E.. W Beggs, Westinghouse Electric Corp., Bloomfield, N. J.

Are We Kidding Ourselves in Industrial Lighting? — Benjamin S. Benson, Jr., Panel Leader, Benjamin Electric Mfg. Co., Des Plaines, Ill.

High Voltage Lighting Distribution Systems — W. D. Jones, W. J. Moran Company.

Flood Lighting — T. H. Shepherd, Panel Leader, Los Angeles Dept. of Water and Power.
1. Richard Riggs, Crouse-Hinds, Los Angeles.
2. George Leyes (Sports Lighting), Westinghouse Electric, San Francisco.
3. William Shalda (Lighting for Advertising), Shalda Mfg. Co., Burbank.
4. J. D. Whitnell, Arizona Public Service Co., Phoenix, Ariz.

Friday Afternoon

Chairman: Gene Smith

Chairman, San Jose Chapter

Office Lighting — John J. Neidhart, Panel Leader, Westinghouse Electric Corp., Cleveland, Ohio.

School Lighting — Charles D. Gibson, State of California, Division of School House Planning.

Lamp Auxiliary Equipment — E. H. Salter, Electrical Testing Laboratories, New York, N. Y.

Lighting for Merchandising
1. Interiors — Carlton M. Thompson, San Diego Gas & Electric Co., San Diego, Calif.
2. Display and Windows — John S. Walsh, Pacific Gas & Electric Co., San Francisco, Calif.

CREDIT DUE

Under the overall direction of F. Jack Rohring as General Chairman, the success of the Conference should be credited to the following:

General Chairman:	F. Jack Rohring
Vice-Chairman:	Merle A. Potter
Attendance:	J. M. Russell
Budget:	William Shalda
Entertainment:	Lloyd C. Reuscher
Finance:	G. A. Hochenauer
Hotel:	Hugh X. Sheeter
Ladies:	Mrs. Roy H. Kreyser
Papers and Program:	Roy Jones
Publicity:	Del Reynolds
Registration:	Wm. P. "Teddy" Bear
Space Arrangements, Program Properties:	Charles Connelly
Transportation:	Benn J. Hartmann

Dan M. Finch, Regional Vice-President
Ed Blair, Chairman
Southern California Section

Public Building Lighting — Theme of Milwaukee Meeting

The seventh annual full-day Spring Conference sponsored by the Milwaukee Section of IES featured the general topic, "Trends in Public Building Lighting." The Conference, which was held May 20 at the Engineers Society of Milwaukee Building, was under the chairmanship of I. L. Illing.

The morning program began with registration at 9 o'clock and the technical papers were:

School Lighting — Darell Boyd Harmon, Consulting Educationist, Austin, Texas.
Hospital Lighting — L. Van Dermark, Chief Electrical Engineer, Schmidt, Garden and Ericson, hospital architects and designers in Chicago.
Office and Bank Lighting — George Gilleard, Assistant Chief Engineer, Curtis Lighting, Inc., Chicago.

(Continued on page 28A)

(Continued from page 27A)

Library Lighting — Richard E. Krug, Milwaukee County Librarian, who has been instrumental in planning revisions and additions to the Milwaukee Public Library.

Buffet lunch was had in the South Dining Room and the afternoon session followed.

Church Lighting — James M. Ketch, in charge of Office, School and Public Building Lighting Section, General Electric Lamp Division, Cleveland.

Color Environment in Public Buildings — Burton H. Monroe, Manager of Paint Sales, Pittsburgh Plate Glass Co., Milwaukee.

Highlights of Public Building Lighting around the World — Merle Keck, Westinghouse Electric Corp., Cleveland.

Panel Discussion on Public Building Lighting — Discussion by all speakers on questions asked.

Other activities of the Milwaukee Section include the first annual extension meeting at Madison, Wisc., April 21, which was attended by approximately 75 people. Midwestern Regional V-P James R. Chambers was special guest of honor. The program featured Don Caverly of Sylvania Electric Products who spoke on Store and Shopping Center Lighting. Other speakers were L. H. Dickelman, Superintendent of Maintenance and Construction, Gimbel Bros., Milwaukee, who discussed "Electronic Control in Store Operation"; and John Burke, Lighting Manager, Wisconsin Power and Light, Madison, whose topic was "Lighting As a Sales Investment."

Mr. Burke, who is Madison Representative of the Section's Extension Activities, was meeting chairman as well as a speaker.

DEMONSTRATION of the "Easy-Baker," new baking device, by George Robinson was one of the many contributions to the success of the two-day conference of the Maritime Chapter, IES, April 22 and 23.

ONE HIGHLIGHT of the two-day conference held by the Maritime Chapter, IES, was the presentation of a certificate of appreciation to D. J. McCarthy, charter member of the Chapter. Here Joseph Thomas, nominee for Canadian Regional V-P, presents the certificate to Mr. McCarthy. Seated at left is T. C. Sargent, guest speaker at the meeting. At right is Chapter Chairman E. L. MacElmon.

Two-Day Conference Huge Success in Maritime Chapter

The highly successful two-day conference held in the Maritime Chapter April 22-23 in Amherst, Nova Scotia, reflects the growing interest and enthusiasm in the activities and objectives of IES in that area. Over 70 members and guests attended the meeting and all agreed that the conference should be a yearly feature of the Chapter.

The conference was under the direction of E. L. MacElmon, Chapter Chairman, and arrangements were made by Mr. MacElmon and George Robinson, Chapter Secretary. The opening speaker was the nominee for Canadian Regional V-P, Joseph Thomas.

Highlight of the first evening was a demonstration by Mr. Robinson of the new baking device called the "Easy-Baker," the first time this equipment has been shown. Other entertainment was handled by J. C. Nickerson.

On the second day, a most informative panel discussion was held, entitled "Should the Power Utility Promote Lighting Installations." This panel was arranged to show the IES at work. Luncheon speaker was Stan Cassidy, an electrical contractor from Fredericton, N. B.

The afternoon session, April 23, featured Ted Sargent, of Sylvania, who gave a talk and demonstration on "Lighting and Color." Other technical sessions included the presentation of the awards for the Chapter's contest for My Most Interesting Lighting Job, which was won by Leslie Mackie, electrical contractor from St. John, for his presentation of St. Vincent's Chapel. Merit certificate for runner-up was presented to George Robinson for his installation at the first TV center in St. John.

A highlight of that evening's festivities was the presentation of a certificate of service recognition to a charter member of the Chapter, D. J. McCarthy, in appreciation of his loyal and active support of the Society in the promotion of better lighting.

Portland, Maine, Is Site Of New England Extension Activity

A meeting, jointly sponsored by the New England Section of IES and the Electrical Associates of Maine, was held April 7 at the Falmouth Hotel, in Portland, Maine. Attendance was 80. Perley E. Weatherbee, IES Local Representative in Portland, was chairman of the meeting.

The two speakers were: Alton T. Littlefield, Vice-President of Central Maine Power Co., who discussed the "fair value" law for power rates; and Lawrence S. Cooke, divisional engineer of General Electric, who spoke on fluorescent lighting techniques, outlining future developments.

400-Cycle Lighting Installation Unveiled in Schenectady

A new lighting system, using 8-foot slimline fluorescent lamps on 400-cycle power, has been completed in the Union College Alumni Memorial Field House, Schenectady, N. Y. The system is the first application of high-frequency lamp operation for the general lighting

(Continued on page 30A)

JOB: Newton Free Library Addition, Newton, Mass.
ARCHITECT: W. Cornell Appleton & Frank A Stearns, Boston.
ENGINEER: Thompson Engineering Company, Boston.
ELECTRICAL CONTRACTOR: Norfolk Electric Co., Boston.
AREA: Approximately 2,400 square feet.
FIXTURES: Luminous Lens Panels as follows:
4 10'-3½" x 8'-0" each w/11-96T12 slimline lamps.
10 2'-9¼" x 8'-0" each w/3-96T12 slimline lamps.
2 2'-9¼" x 4'-0" each w/3-48T12 slimline lamps.
WATTS PER SQUARE FOOT: 2.9 approximately.
AVERAGE INTENSITY: On table tops, 75 footcandles in service. Average over room, 57 footcandles in service.
BRIGHTNESS READINGS: Walls .045 candle per square inch. Floor .019 candle per square inch. Table top .069 candle per square inch. Fixture—Across lamp axis: At 45°, 0.72 candle per square inch. At 30°, 0.29 candle per square inch.

The Torch of Learning *Glows More Brightly* with LITECONTROL Lighting

Geared for learning, planned for seeing . . . here's a library where high-level visibility goes hand-in-hand with high I.Q.

A custom job? Surely . . . *in everything but price!*

For LITECONTROL specializes in making a comprehensive line of standard fixtures for every conceivable requirement . . . and fitting them to specific applications for the best results.

Thus, with LITECONTROL you get the right light in the right place with the right appearance . . . at the least cost.

On your next job, call in your LITECONTROL representative.

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

STREET Lighting Conference, held in Boston, was composed of five weekly sessions, March 22 through April 21. Here on opening night are, from left to right: John W. Young, W. P. Lowell, Jr., E. J. Perkins and L. E. Innis.

palities, state engineers, private consulting engineers, contractors, lamp and equipment manufacturers and students.

The weekly meetings covered:

March 22 — Introduction to Street Lighting Importance, objectives and introduction to the code—E. J. Perkins, Holophane Co., Inc. Light sources — Incandescent, L. E. Innis, Sylvania Electric Products Inc.; Arc Discharge, W. P. Lowell, Jr., Sylvania Electric Products, Inc.

March 31 — Fundamentals of Street Lighting —P. N. Clerke, Westinghouse Electric Corp.

April 7 — Applications — Layout Principles and Street Lighting Code — C. R. Brewer, General Electric Co.

April 14 — Special Situations and New Approaches — W. B. Elmer, Wheeler Reflector Co.

April 21 — Available Equipment and Installation Practice — C. E. Whitaker, The Narragansett Electric Co.

IES Represented at Engineering Functions

Two Officers of IES recently represented the Society at occasions of engineering significance. Vice-President Marshall N. Waterman was the delegate to the celebrations of the 75th Anniversary of the American Society of Mechanical Engineers, which was held, April 16, at the Assembly Hall of Stevens Institute of Technology, Hoboken, N. J. At the convocation, Vice-President Waterman presented greetings and congratulations to ASME from IES.

And on April 30, in Worcester, Mass., Northeastern Regional V-P C. W. McCormick represented the Society at the inaugural of Dr. Arthur B. Brownell, as President of the Worcester Polytechnic Institute.

(Continued on page 33A)

(Continued from page 28A)

of a large area. Increasing the standard 60 cycles to 400-cycle frequency is accomplished by means of two 30-kilowatt rotating-type package-unit frequency converters. The system was designed and developed by the General Electric Company. John H. Campbell, G-E illuminating engineer, conceived and developed the technique.

Illumination level in the field house is between 45 and 50 footcandles. Lighting fixtures, designed by Carl J. Allen, are mounted at heights varying from 60 feet in the center to 34 feet on the sides.

Street Lighting Conference Sponsored in New England

Five weekly sessions on street lighting, designed to present an up-to-date picture of the basic fundamentals, comprised a Street Lighting Conference, sponsored March 22 through April 21, by the New England Section of IES and the Lighting Bureau of the Electric Institute, Inc., in Boston.

The two-hour evening sessions were held in the auditorium of the New England Power Building, Boston, and the attendance of 75 represented a wide field of endeavor including utilities, munici-

Lighting Maintenance Contractors Hold Second Annual Meeting

The National Association of Lighting Maintenance Contractors, a group originated last year in Cincinnati, held a three-day conference April 25 through April 27 in Atlanta, Ga., with exchange of methods, sales promotion and advertising media important topics of discussion. Also on the agenda was the adoption of by-laws and the election of the following officers for the coming year:

President — Walter C. Fink, Jr., Atlanta, Ga.
Secretary-Treasurer — Francis Clark, Waterbury, Conn.
Vice-Presidents — Samuel Feldman, Allston, Mass.; Malger Gray, Tampa, Fla.; Herbert Mendelsohn, Kansas City, Mo.; Robert Watson, Denver, Colo.; Jerome Gimbel, Chicago, Ill.

Next year's conference has been scheduled to be held in Hershey, Pa.

ATTENDING the second annual meeting of the National Association of Lighting Maintenance Contractors were 30 men representing 23 companies.

MAKING NEWS!

Steady Sales Increase Sighted By Advance Executive

In an exclusive interview with J. C. Hamilton, Sales Executive of Advance Transformer Company, it was revealed that sales of Advance ballasts have shown a steady increase in the last three years.

"Advance ballasts have become recognized as a quality product in the fluorescent lighting field," he said, "and more architects are specifying Advance exclusively."

Engineers Announce Revolutionary Design For Fluorescent Lamp Ballasts

With the announcement of the new BRQ 2-S-110 ballast for the 96-T-12 lamp at 800 ma. in a Rapid Start design, an entirely new concept in the field of fluorescent lighting is said to be in prospect. All in all, approximately a 30% reduction in size, this ballast immediately brings the fixture manufacturer a new latitude for housing and ventilation, both more efficient and less costly in the final pricing of fixtures. Approximately one-third weight is also a big factor. Make modern and ver... a big f... tallation...

Mr. Max Orr, vice president in charge of sales, stated, "This new ballast will offer the lighting fixture manufacturer, architect, lighting engineer and general lighting

Mr. Lou Duman, Pre... Advance Transformer announced the perfection... duction of this new and advanced ballast which w... immediate production.

"Ever conscious of to... consistent with price," "our engineers design a... to assure the maximum... able service."

Increased efficiency ... effected with the new ... 2-S-110 Rapid Start ... Ballast. This is accomp... radically new design ... system of assembly ... wholly by Advance ... Company engineers. ... ceded to add stability ... life to the performanc... last. Optimum effectiv... obtained without elim...

NOW! 96T12

CATALOG # BRQ 2-S-110

RAPID START FLUORESCENT LAMP BALLAST

	approx.	
Smaller		30% REDUCTION
Lighter Weight		28% REDUCTION
More Efficient		30% INCREASE

lighter weight and therefore more ... ballast which will de...

More Efficiency In New BRQ 2-S-110 Advance Ballast

ADVANCE TRANSFORMER CO.

Cable Address "ADTRANS"

2950 N. WESTERN AVENUE

CHICAGO 18, ILLINOIS, U.S.A.

NOW 90% EFFICIENCY

with Eastern's "N" SERIES FIXTURES

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SCHOOLS, OFFICES & PUBLIC BUILDINGS

Featuring:

- 90% EFFICIENCY
- ONE MAN LOUVER INSTALLATION
- EXCLUSIVE "VIBRA-LOCK" END SECTION
- CONFORMS WITH A.S.A. REQUIREMENTS
- PLASTIC OR METAL SIDE PANELS
- SIMPLE LOW COST MAINTENANCE
- AVAILABLE IN 3 CUTOFFS
  35° — 25°, 35° — 45°, 45° — 45°
- FLUORESCENT OR SLIMLINE
  4, 6, 8 FOOT UNITS

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PRESENTATION of awards in the Ohio Valley Section Architectural Competition was made April 19. Section Chairman Beattie M. DeLong hands the first-place award to student Richard Stauffer as Honorable Mentions Philip Zeigler and Robert Frasca look on.

Awards Presented in Ohio Valley Student Contest

The second section of the Architectural Student Competition came to a close and the winners in both sections were announced at the April meeting of the Ohio Valley Section of I.E.S., sponsors of the contest at the University of Cincinnati. The problem was the design and development of lighting an apartment building, with stress on the dramatic use of light, particularly in the public areas.

Winning students were:

SECTION I — First Place — Richard Stauffer; Honorable Mentions — Philip Zeigler and Robert Frasca.

SECTION II — First Place — Richard Blankenship; Honorable Mentions — Harry Driggs and Joe Shaw.

Leonard P. Cohron and Robert W. Brown acted as the committee who arranged the details of the competition, and also as judges for IES. Other judges were Robert A. Deshon and Robert W. Dayton, both assistant professors of architecture at the University of Cincinnati.

Electrical Contractors Featured In Philadelphia Section

The entire program of the March 8 meeting of the Philadelphia Section of IES was devoted to electrical contractors. For the first time in the Section's history the five first prize winners of the 1954 Electrical Contractors Planned Lighting Contest presented and discussed their winning entries. Another event was the presentation of awards to contractors who had winning entries in the Light's

(Continued on page 34A)

LIGHTING CALENDAR

Society Events

June 10-11, 1955 — Northeastern Regional Conference, Ft. William Henry Hotel, Lake George, N. Y.

September 12-16, 1955 — Illuminating Engineering Society, National Technical Conference, Hotel Statler, Cleveland, Ohio.

Industry Events

June 12-15, 1955 — Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, Calif.

June 13-16, 1955 — Edison Electric Institute, Annual Convention, Los Angeles, Calif.

June 13-22, 1955 — International Commission on Illumination (CIE), 13th Session, Zurich, Switzerland.

June 20-24, 1955 — American Society for Engineering Education, Pennsylvania State University, State College, Pa.

June 26 - July 1, 1955 — American Society for Testing Materials, 58th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27 - July 1, 1955 — American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

August 15-19, 1955 — American Institute of Electrical Engineers, Pacific General Meeting, Butte, Montana.

September 25-28, 1955 — National Association of Electrical Distributors, Annual Convention, Pacific Zone, Empress Hotel, Victoria, B. C.

September 27-29, 1955 — Electrical Progress Show, Convention Hall, Philadelphia, Pa.

October 1, 1955 (Tentative) — Institute of Traffic Engineers, 26th Annual Meeting, Pittsburgh, Pa.

October 3-5, 1955—National Electronics Conference, Hotel Sherman, Chicago, Ill.

October 3-7, 1955 — Society of Motion Picture and Television Engineers, 78th Semi-annual Convention, Lake Placid Club, Essex County, N. Y.

October 3-7, 1955 — American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago, Ill.

October 5-7, 1955 — Canadian Electrical Manufacturers Association (11th Annual Meeting), Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

October 11-14, 1955 — National Electrical Industries Show, 69th Regiment Armory, New York, N. Y.

October 17-21, 1955 — National Safety Council, 43rd National Safety Congress & Exposition, Chicago, Ill.

October 24-26, 1955 — 37th Annual Meeting and Sixth National Conference on Standards, American Standards Association, Washington, D. C.

October 30, 1955—Week of—National Electrical Contractors Association, Waldorf-Astoria, New York, N. Y.

November 1-3, 1955 — Fifth Industrial Electric Exposition, Hotel Wm. Penn, Pittsburgh, Pa.

November 2-5, 1955 — National Electrical Contractors Association, Annual Convention, Waldorf-Astoria Hotel, New York, N. Y.

November 14-18, 1955 — National Electrical Manufacturers Association, Annual Meeting, Traymore Hotel, Atlantic City, N. J.

November 14-18, 1955 — Chicago Exposition & Power and Mechanical Engineers ASME Chicago Coliseum, Chicago, Ill.

Open Letter to I.E.S. Members

The I.E.S. Research Planning Committee has been asked to serve as a clearing-house for projects on illumination and light and vision. If you have a project which you think needs investigation, please send your suggestion to the Committee Chairman, or to C. L. Crouch, I.E.S. Technical Director.

Likewise, if you need a suggestion, perhaps for a college thesis subject, apply in the same way to the

RESEARCH PLANNING COMMITTEE
Willard Allphin, *Chairman*

S. K. Guth — R. C. Putnam
H. L. Logan — D. E. Spencer

(Continued from page 33A)

Diamond Jubilee Lighting Competition which was sponsored by *Electrical Construction and Maintenance*.

The third item on the program was the presentation of prizes and plaques to the winning contractors in the Fall Lighting Campaign conducted last season.

ABOUT PEOPLE

Paul F. Kauffman was elected to the grade of Member Emeritus of I.E.S. by unanimous action of Council at its April meeting in Phoenix, Arizona. Mr. Kauffman, who has been an active member of the Chicago Section for over thirty years, retired last year from the Commonwealth Edison Company.

The miniature and automotive lamp sales department of the Westinghouse Lamp Division has been expanded to include Christmas tree lamps, Sterilamp ultraviolet lamps, fluorescent sun lamps, rectigon bulbs and the Tenderay meat tenderizing process. The new department is headed by **C. W. Flood, Jr.**, who has been manager of miniature and automotive lamp sales since November 1953. **Robert M. Harris** has been named to assist Mr. Flood.

The appointment of **Joseph F. Miller** as Managing Director of the National Electrical Manufacturers Association has been announced by A. F. Metz, President. Mr. Miller, who has been Assistant Managing Director for the last year, succeeds **William J. Donald**, who retired April 30.

The Better Light Better Sight Bureau has announced two new appointments to the Executive Committee. **James C. Forbes**, Manager of Market Development, Large Lamp Dept., General Electric Co., replaces **W. H. Robinson, Jr.**, and **C. A. Burton**, General Sales Manager, Lighting Division, Sylvania Electric Products, Inc., is replacing **B. K. Wickstrum**.

Lawrence A. Appley, President of the American Management Association, has been elected a Director of Sylvania Electric Products, Inc. His election increases the Board from nine to ten members.

Advance Transformer Co., Chicago, has announced the appointment of **E. H. Gallet** as Manager, Marketing Services. Mr. Gallet will coordinate Sales Promotion and Advertising activities, serve as the company's liaison between distributors, contractors and architects, and assist with product planning. He was formerly associated with Curtis Lighting and Benjamin Electric Mfg. Co.

At the annual stockholders meeting of the F. W. Wakefield Brass Co., Vermilion, Ohio, the corporate name was changed to The Wakefield Company. General Manager **A. F. Wakefield** gave two reasons for the change: that F. W. Wakefield who founded the company has long been deceased, and that the word "brass" has been misleading.

New organizational changes affecting managerial personnel of General Electric Lamp Division's sales districts have been announced. **Jack M. Lime** has been appointed retail sales manager for the Large Lamp Department at Nela Park, succeeding **Theodore C. Ohart**, who will head marketing for the Silicone Products Division in Waterford, N. Y. **George S. Trotter** has been named manager of the Buckeye Sales District in Cleveland. Succeeding Mr. Trotter as manager of Texas Gulf Sales District will be **Theodore C. Lanck**. **Gordon E. Brown** has been named to replace Mr. Lanck as manager of the Delta Sales District in New Orleans.

In line with a proposed expansion program, Solar Electric Corp., Warren, Pa., announces the recent appointment of **Walter J. Dremann** as President. Mr. Dremann has, for the past two years, been Vice-President and General Manager for Solar.

The election of **Arthur L. Milk** as a Vice-President of Sylvania Electric Products, Inc., has been announced. Mr. Milk has been the company's director of government relations since 1947, and will continue to serve as head of the Government Relations Dept., with headquarters in Washington, D. C.

Three new directors were elected by shareholders of Jefferson Electric Co., at the annual meeting held recently in Bellwood, Ill. They are **Charles L.** Coughlin, president of the Briggs and Stratton Corp.; **Otis S. Mansell**, president of the Celotex Corp.; and **George Skakel**, president of the Great Lakes Carbon Corp.

The appointment of **Allan W. Larson** as sales manager of the lighting division of Westinghouse Electric Corp. Mr. Larson fills the post recently made vacant by the appointment of **E. C. Huerkamp** as division manager.

Ervin Baker has been appointed manager of rural lighting sales by Sylvania Electric Products, Inc., and will make his headquarters at the company's Salem, Mass., offices. Mr. Baker was employed until recently as agricultural engineer and head of Member Services Dept. by the Kentucky Association of Rural Electric Co-operatives in Louisville, Ky.

Ned Landon has been named manager of public information at the General Electric Research Laboratory. Mr. Landon joined the staff at the Laboratory as information specialist last year, previously having been director of public relations at Knox College, Galesburg, Ill.

The appointment of three men to the position of senior salesmen for Jefferson Electric Co., Bellwood, Ill., has been announced by the company. **Robert H. Korman** has been promoted to this post with headquarters in Indianapolis, Ind.; **John E. Hazen** will fill this position in Westwood, N. J.; and **John G. Stanwood** has been named senior salesman in Baltimore, Md.

Sumner Harris has been appointed Lighting Division salesman supervisor for the Southern Texas area by Sylvania Electric Products Inc. Mr. Harris has been sales representative in the Dallas district since 1951.

Two executive appointments in the production and sales organization of Litecraft Manufacturing Corp., New York City, have been announced. **Max D. Holzman** and **Bert Berend** were named as General Manager and Metropolitan District Sales Manager, respectively, for the company. Mr. Holzman formerly headed the Specialty Lighting

(Continued on page 36A)

I.E.S. National Technical Conferences

1955 — September 12-16 — Hotel Statler, Cleveland, Ohio

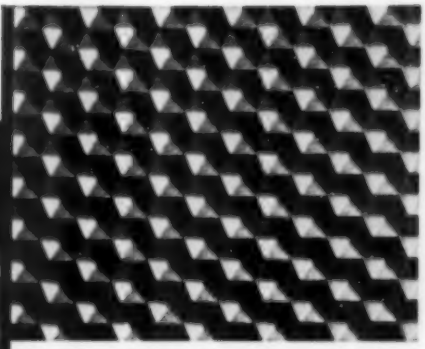
1956 — September 17-21 — Hotel Statler, Boston, Massachusetts

1957 — September 9-13 — Biltmore Hotel, Atlanta, Georgia

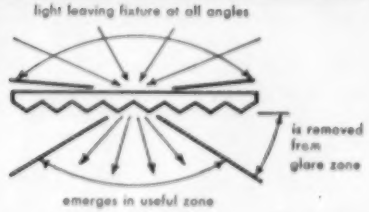
1958 — August 17-22 — Royal York Hotel, Toronto, Ontario

ARCHITECT'S AND ENGINEER'S FACT SHEET

Photo—Ezra Stoller. Pattern 70 installation at the Manufacturers Trust Company's new Fifth Avenue Office in New York. Architects—Skidmore Owings and Merrill.



Close-up view of Pattern No. 70, a prismatic crystal lens panel. You can get Pattern No. 70 in widths up to 34 inches, lengths up to 100 inches.



Working diagram. Light enters panel from fixture (top) at all angles. Prisms gather light, transmit it to useful zone.

CORNING PATTERN No. 70

Lightweight . . . Low-Brightness Lens Panel

You use Corning Pattern No. 70 to deliver maximum light in the useful zone with lov brightness in the glare zone.

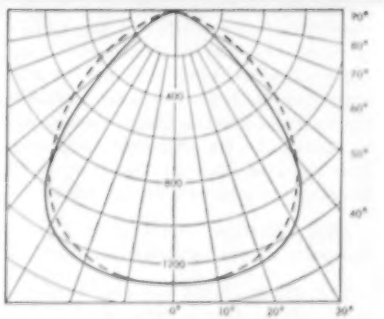
A pattern of hexagonal prisms on one surface controls the light. These prisms bend light rays downward creating more useful illumination. Light in the near horizontal angles is reduced so that surface brightness of the panel is low at normal viewing angles.

Result is a distribution of emitted light in a pattern of even illumination on the working surface.

Lightweight—just 1.75 pounds to the square foot. You can get panels up to 100 inches long—for one-piece fixtures that eliminate dust- and light-leaking seams. Water-white crystal, dimensionally stable glass. Won't warp, fade, discolor, or show age. Has no dust-attracting static charge. Cleans easily.

Recommended for luminous elements, troffers and fixtures in schools, banks, offices — *wherever* you want low brightness.

For free information about this interesting and useful lighting-ware, please use the coupon.



Candle power distribution

——Across axis ---Thru axis

Two 40-watt 3500° lamps (4960 lumens). White Enamel Reflector, 80% R. F., 11" x 48" segment. No. 70 Low-Brightness Lens Panel.

White Reflector and Pattern No. 70 Low-Brightness Lens Panel.

CORNING GLASS WORKS
CORNING, N. Y.

Corning means research in Glass

CORNING GLASS WORKS, 68-6 Crystal Street, Corning, N. Y.

Please send me Bulletin LS-47A: "New Corning Pattern No. 70 Low-Brightness Lens Panel."

Name.....Title.....

Firm.....

Address.....

City.....Zone.....State.....

(Continued from page 34A)

Fixtures Contract Division of Central Queens Electric Supply Corp., Mr. Berend, president of the Lighting, Lamp and Electrical Manufacturers Salesmen's Association, has been associated with the Ruby-Philite Corp.

OBITUARIES

John E. Randall, pioneer leader in the electric lamp business and organizer of what is today the Lamp Development Laboratory of General Electric's Lamp Division, died April 22 after a long illness at Jamestown, N. Y. He was 93.

Identified with the electrical industry for 45 years, Mr. Randall was engaged for 28 years in lamp development activities for General Electric. Following five years as manager of Lamp Development Laboratory, Mr. Randall continued for 17 years in a consulting capacity, retiring from active service in 1931.

Mr. Randall became associated with the electrical business in 1886, when he joined the Thomson-Houston Co. as an electrician and specialist in experimental work. In 1893 he joined Columbia Lamp Co. in St. Louis and in 1903 was appointed filament and lamp engineer for National Electric Lamp Association in Cleveland. He organized, equipped and operated General Electric's first tungsten lamp factory in Cleveland.

I.E.S. Sections report with sorrow the death of the following members:

R. J. Crump, Past-Chairman, Southern California Section — Division of Architecture and Engineering, University of California, Los Angeles, Calif.

Earl H. Keller, New York Section — Sales Engineer, Erb Electric Supply Co., New York, N. Y.

J. B. Williams, Ohio Valley Section — Manager of the Lamp Division, Gustav Hirsch Organization, Columbus, Ohio.

John H. Waterbury, Member Emeritus of the Chicago Section, retired from Benjamin Electric Mfg. Co. in 1953.

BOOKS AND PAMPHLETS

Lamps for a Brighter America, by Paul W. Keating, published by McGraw-Hill Book Company Inc., New York 36, N. Y. 246 pages, illustrated and indexed. Price $4.00.

The subtitle "A History of the General Electric Lamp Business" is an appropriate description of the book, which traces the 75-year history of lamp bulbs and of the General Electric Co. lamp business. This development covers many aspects from research, engineering and scientific achievement to legal problems, management, promotion and industrial progress. The author has spent 20 years writing about all aspects of the lighting field. This has brought him into close contact with many manufacturers, utilities, and trade associations including the Edison Electric Institute and the Better Light Better Sight Bureau.

The 1955 edition of the **Heating Ventilating Air Conditioning Guide,** which is published annually by the ASHACE, is now available from the American Society of Heating and Air-Conditioning Engineers, 62 Worth Street, New York 13, N. Y. The Technical Data Section, of this 33rd edition, contains 53 chapters (1160 pages) illustrated with charts and tables, a 24-page subject index and an edge index. The publishers state that several chapters in this section have been almost entirely rewritten and that many illustrations throughout the book were improved for this edition. They also state that this edition provides an enlarged and useful Catalog Data Section of reference material on products of 328 well-known manufacturers of the heating, ventilating and air conditioning equipment. This section is also provided with a comprehensive page index, and an edge index for rapid reference to any type of equipment. Price $12.00.

ASTM Proceedings, 1954 edition, has recently been published. The 1400-page volume records the technical accomplishments of the American Society for Testing Materials for 1954, including many technical reports and papers together with discussion which have been offered during the year. Copies of the Proceedings are available from ASTM, 1916 Race St., Philadelphia 3, Pa. Price $12.00 per copy.

Flexibility in the Coordinated Classroom, a 32-page brochure, by Dr. D. B. Harmon, Consulting Educationist, has been published by the E. F. Hauserman Company as a reference guide for educators and school administrative officials. In its four chapters, on Modern Education and the School Interior, Teaching Surfaces and Space Dividers, Interior Space Reorganization, and Economics in the Modern Interior, Dr. Harmon explores the subject of school interior flexibility and its impact on the psychological and physical environment of the child as well as requirements of the community. The booklet is available upon request from The Wakefield Co., Vermilion, Ohio.

Another booklet by Dr. Harmon published recently is **Wakefield Lighting, As Flexible as Your Classrooms,** which covers: Vision and Learning, Adaptation, Task Lighting Needs, Flexible Classrooms, Flexible Lighting, Rehabilitation, as well as applications of the company's equipment in schools. This booklet is also directed at the school administrator as an educational piece on a new concept of school lighting.

Commercial-Industrial Planned Lighting Program is a collection of sales aids designed to assist utility companies in increasing consumer lighting sales. The material contains direct mail pieces, customer handout booklets and a bibliography of lighting literature to back up sales personnel in attempts to raise lighting standards. It has been prepared by the Commercial Lighting Committee and the General Power and Heating Committees of the Edison Electric Institute, and is available from EEI, 420 Lexington Ave., New York 17, N. Y.

Series Streetlighting Systems, Bulletin B-6513, discusses the operating characteristics of mercury lamps on series streetlighting system and analyzes requirements for auxiliary equipment. Wiring diagrams for both straight series circuits and cascade operation provide a basis for design and installation of series lighting systems. Photographs illustrate principal equipment required. The booklet is available from Westinghouse Electric Corp., Lighting Division, Edgewater Park, Cleveland, Ohio.

NEW MEMBERS

At a meeting of the Council Executive Committee of I.E.S., held May 12 in New York City, the following were elected to membership. Names marked * are transfers from Associate Grade.

ALABAMA CHAPTER

Associate Members:
Bunt, J. W., Wells Electric Supply Co., Inc., Birmingham, Ala.
Tucker, Gewin, Wells Electric Supply Co., Inc., Birmingham, Ala.

ARIZONA SECTION

Member:
Hartley, B. H., P. O. Box 4381, Phoenix, Ariz.

Associate Member:
Toma, Steven, Steven Toma Co., Phoenix, Ariz.

ARKANSAS CHAPTER

Associate Members:
Hancock, J. V., Gregory Salisbury, Little Rock, Ark.
Stephenson, J. C., Arkansas Power & Light Co., Pine Bluff, Ark.

(Continued on page 38A)

Eye Comfort and Higher Standards with New Day-Brite CFI fixtures

Just seeing isn't enough, even if illumination is considered adequate. It's eye comfort that makes the big difference, as the above "before and after" photograph of the same work area clearly shows.

To assure needed eye comfort for workers—resulting in higher efficiency and morale—Day-Brite is offering a new concept in industrial lighting. It is the famous Day-Brite CFI fixture—so-called because CFI means *C*omfort *F*or *I*ndustry. This new unit washes out ceiling contrasts, which can result in nervous and muscular fatigue.

There are two CFI units available—the CFI-10 (which provides a 10% upward lighting component) and the CFI-25 (which provides a 25% upward component). They are designed to meet any seeing requirements in industry.

5469

SEE! EXAMINE! COMPARE! The safest way to assure yourself of selecting the right fixture is to make a point-by-point comparison of various fixtures under consideration. Then choose on the basis of the evidence.

CALL YOUR DAY-BRITE REPRESENTATIVE! Long experience makes him competent to advise you.

Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo.

NATION'S LARGEST MANUFACTURER OF COMMERCIAL & INDUSTRIAL LIGHTING EQUIPMENT

An ELEFILAMENT never forgets. *Do You?*

Starting small, the Elefilament glows and grows until he becomes a bulky barrier to effective and economical lighting, unless you set a trap for him by maintaining good lamps and good lamp care at all times.

By good lamps we mean CHAMPION Lamps, made specially to meet the highest standards of industrial lighting.

CHAMPION Lamps

By good lamp care we mean the simple, effective maintenance measures described in the Champion Maintenance Manual, copy of which is yours for the asking.

CHAMPION LAMP WORKS

306 Lynnway, Lynn, Massachusetts

(Continued from page 36A)

BRITISH COLUMBIA SECTION

Member:
*McGregor, Chris, Simpson & McGregor, Vancouver, B. C.

Associate Members:
Foster, H. G., Northern Electric Co., Ltd., Vancouver, B. C.
Smith, W. E., Ricketts Sewell Electric, Ltd., Vancouver, B. C.
Stenhouse, H., Northern Electric Co., Ltd., Vancouver, B. C.

CAPITAL SECTION

Member:
*Lewis, A. L., Bureau of Aeronautics, Dept. of the Navy, Washington, D. C.

Associate Member:
Cockrill, C. R., Moe Light & Co., Ft. Atkinson, Wisc.

CENTRAL NEW YORK SECTION

Associate Member:
Larmann, A. F., Jr., General Electric Co., Syracuse, N. Y.

CHICAGO SECTION

Member:
*Schneller, J. A., Lighting Products, Inc., Highland Park, Ill.

Associate Members:
Brown, W. M., Murray Rosenblum & Co., Chicago, Ill.
Furst, W. C., General Electric Co., Chicago, Ill.
Martin, J. B., B. J. Martin & Co., Chicago, Ill.
McDonald, C. T., Jr., Multi Electric Mfg. Co., Chicago, Ill.
Kunce, Bernard, Lee Electrical Construction, Chicago, Ill.
Sharman, S. J., Graybar Electric Corp., Chicago, Ill.
Shaw, G. J., Shaw Electric Co., Chicago, Ill.
Wahlen, F. E., Village of Oak Park, Oak Park, Ill.

Student Member:
Belsan, Roger, University of Illinois, Urbana, Ill.

CLEVELAND SECTION

Member:
*Falk, Norman, Holophane Co., Inc., Cleveland, Ohio.

Associate Members:
Frisina, F. R., Cleveland Electric Illuminating Co., Cleveland, Ohio.
Powell, J. R., Westinghouse Electric Corp., Cleveland, Ohio.
Wright, H. L., Jr., Stevenson & Wright, Cleveland, Ohio.

CONNECTICUT SECTION

Associate Members:
Bass, C. E., Connecticut Light and Power Co., Waterbury, Conn.
Kemp, R. W., The Joslyn Co., Wallingford, Conn.

CORNHUSKER CHAPTER

Associate Member:
Engelhardt, Fred, Omaha Public Power District, Omaha, Neb.

EASTERN PENNSYLVANIA SECTION

Associate Members:
Franke, K. D., Bethlehem Steel Co., Bethlehem, Pa.
Hasler, C. A., 2067 W. Market, Pottsville, Pa.

FLORIDA SECTION

Associate Members:
Frey, A. L., Optometrist, 1009-11 First National Bank Bldg., Tampa, Fla.
Williams, W. T., General Electric Co., Tampa, Fla.

FOREIGN NON-SECTION

Member:
*Lopez, J. N., E. J. Mora Electric Co., Inc., Port Area, Manila, Philippine Islands.

Associate Member:
Oberman, Leslie, White-Lite (Vic) Pty, Ltd., S. Melbourne, Victoria, Australia.

Student Member:
Bonin, F. M., Thorn Electrical Industries Ltd., Enfield, Middn, England.

HAMILTON ONTARIO CHAPTER

Associate Member:
Quist, J. E., 12 Sunnyside Dr., St. Catherines, Ont.

INDIANA SECTION

Associate Members:

Gater, Ros, Duro Test Corp., Indianapolis, Ind.

Huston, D. R., Huston Electric, Kokomo, Ind.

Rice, C. O., Lennox & Matthews & Assoc., Indianapolis, Ind.

Stuart, A. J., Hugh J. Baker Co., Indianapolis, Ind.

MARITIME CHAPTER

Associate Members:

Flynn, A. A., Canadian Westinghouse Supply Corp., Halifax, N. S.

Levins, J. R., Amalgamated Electric Corp., Halifax, N. S.

Mackie, L. A., George Mackie & Sons, St. John, N. B.

MARYLAND SECTION

Associate Member:

Dunlop, Richard, Dunlop Lighting, Baltimore, Md.

MEXICO CHAPTER

Associate Member:

Fournier, Juan Francisco, Industrial Dufermex, S. A., Mexico, D. F.

MICHIGAN SECTION

Member:

Young, P. L., Public Lighting Commission, Detroit, Mich.

MILWAUKEE SECTION

Member:

*Lisch, W. N., Lisch Electric Co., Milwaukee, Wisc.

Associate Members:

Arndt, C. J., The F. W. Wakefield Brass Co., Wauwatosa, Wisc.

Culver, D. S., Culver Electric Supply Co., Madison, Wisc.

Verwiel, J. C., Capital Electric Co., Madison, Wisc.

MISSISSIPPI CHAPTER

Associate Member:

Smith, D. T., 512 Broadway Ave., Jackson, Miss.

MONTREAL SECTION

Members:

*Frick, D. W., Canadian Broadcasting Corp., Montreal, Que.

*Stubbings, V. W., The Holophane Co., Ltd., Toronto, Ont.

Associate Member:

Arcand, Hubert, Guy Belanger, Montreal, Que.

NEW ENGLAND SECTION

Member:

*Caldwell, W. S., Jr., Chas. T. Main, Inc., Boston, Mass.

Associate Members:

Burn, G. M. Sylvania Electric Products, Inc., Salem, Mass.

Stohn, A. C., Jr., The Fisher Pierce Co., S. Braintree, Mass.

NEW ORLEANS SECTION

Associate Members:

Ber, J. M., Electrical Supply Co., New Orleans, La.

Carter, C. C., Jr., General Electric Co., New Orleans, La.

NEW YORK SECTION

Associate Members:

Carino, R. J., Day-Brite Lighting, Inc., New York, N. Y.

Eastment, D. M., Long Island Lighting Co., Mineola, N. Y.

Lieberman, Lawrence, 320 W. 76th St., New York, N. Y.

Student Member:

Cline, J. G., Marquette University, Milwaukee, Wisc.

NORTHERN CALIFORNIA SECTION

Associate Members:

Bell, Dewey, Electrical Products Corp., San Francisco, Calif.

Benjamin, J. C., Standard Oil Co. of California, San Francisco, Calif.

Brumfield, E. H., Brumfield Electric Sign Co., San Francisco, Calif.

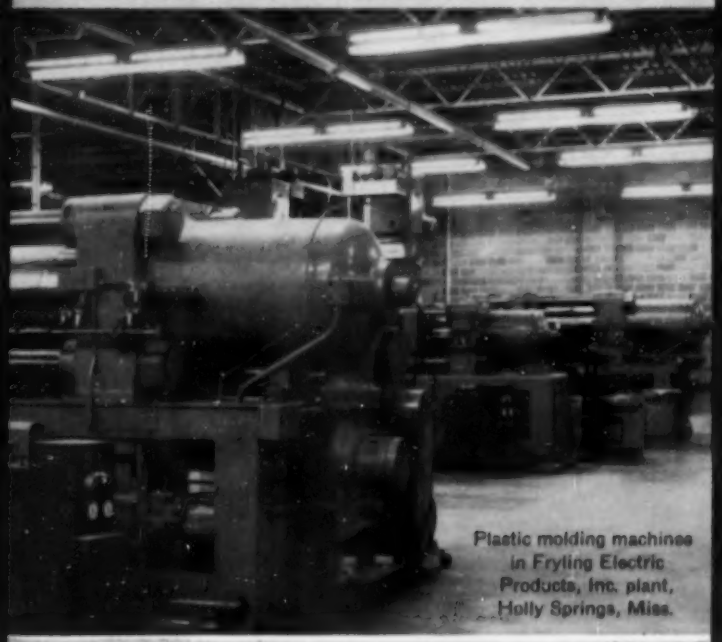
Cope, G. H., C. T. Bakeman & Associates, San Francisco, Calif.

Chapman, W. K., Sylvania Electric Products, Inc., Emeryville, Calif.

Jensen, M. S., Pacific Gas & Electric Co., Ukiah, Calif.

(Continued on page 40A)

In Mississippi, Too...
The Choice Was L & P Fixtures!



Plastic molding machines in Fryling Electric Products, Inc. plant, Holly Springs, Miss.

These specially made fluorescent fixtures in the Fryling Electric Products, Inc. plant (Holly Springs, Miss.) prove once again the advantages of L & P fixtures--because they're designed, engineered and manufactured, every step of the way, right in our own plant.

That's why, in Mississippi, too -- for extra efficiency at no extra cost -- the choice was L & P!

LIGHT & POWER UTILITIES CORP. L&P

Light & Power Utilities Corp.
1035 Firestone Blvd.
Memphis, Tennessee

Fryling Electric Products, Inc. plant, Holly Springs, Miss.

(Continued from page 39A)

Parke, S. E., Westinghouse Electric Supply, Oakland, Calif.
Wilhelmy, J. W., Pacific Gas & Electric Co., Oakland, Calif.
Williams, A. R., Architect, 521 Post St., San Francisco, Calif.

OHIO VALLEY SECTION

Associate Member:
Pollard, S. C., General Electric Co., Cincinnati, Ohio.

OIL CAPITAL CHAPTER

Associate Members:
Moore, H. L., Moore Electric, Oklahoma City, Okla.
Slief, L. O., Oklahoma Gas & Electric Co., Enid, Okla.
Taylor, G. A., Watt Plumbing, Air-Conditioning & Electric, Tulsa, Okla.

OREGON SECTION

Associate Members:
Dunn, L. M., Jr., General Electric Co., Portland, Ore.
Farley, F. A., Eoff Electric, Portland, Ore.

PALMETTO CHAPTER

Associate Member:
Gordon, J. C., Huntington & Guerry Electric Co., Greenville, S. C.

PHILADELPHIA SECTION

Member:
Swing, H. P., The Ballinger Co., Philadelphia, Pa.

Associate Members:
Burns, J. J., Jr., University of Pennsylvania, Philadelphia, Pa.
Fadden, L. D., Philadelphia Electric Co., Philadelphia, Pa.
Lawrence, I. M., Corning Glass Works, Corning, N. Y.

NEW LIGHTING
DIMENSIONS
FOR YOUR
INTERIORS
4'x4'
QPLM4800-48 Miniature-celled plastic louver
What is more important to architects than "scale"—a sense of proportion and thoughtful consideration for textural and tactual qualities in materials. Sunbeam lighting engineers, appreciating these aesthetic values and adding a few practical factors, have incorporated a new light diffusing medium in many Sunbeam Visionaires®. A miniature-celled, light stable, molded plastic, translucent white louver is available for Sunbeam's 4 by 4, 2 by 4 and 1 by 4 recessed and surface mounted units. Acting as a single, removable panel in each type of fixture, this louver provides excellent diffusion, 45° shielding and high efficiency. A pleasing textural quality is added to the luminous surfaces of these units which blends with contemporary ceiling structures.
SUNBEAM
visionaire
SUNBEAM LIGHTING COMPANY
777 East 14th Pl., Los Angeles 21, Calif.

Stiles, David, The Pyle National Co., Philadelphia, Pa.
Watt, G. E., Philadelphia Electric Co., Philadelphia, Pa.

PITTSBURGH SECTION

Associate Members:
Cashdollar, W. G., Pittsburgh Reflecter Co., Pittsburgh, Pa.
Fair, William, James A. Hodges Co., Pittsburgh, Pa.
Latton, G. C., General Electric Co., Pittsburgh, Pa.
Reeve, G. J., E. C. Ernst Inc., Pittsburgh, Pa.
Vinocur, D. A., Pittsburgh Electric Supply Co., Pittsburgh, Pa.

PUGET SOUND SECTION

Associate Members:
Byrnes, C. P., Jr., Grinnell Co. of the Pacific, Seattle, Wash.
Chaffer, J. R., Johnson & Botesch, Everett, Wash.
Stallman, George, 568 1st So., Seattle, Wash.
Wells, J. H., B. T. Heinz Co., Seattle, Wash.

ROCKY MOUNTAIN SECTION

Associate Members:
Condon, H. F., Howard F. Condon Co., Denver, Colo.
Linch, Harry, 1690 Detroit, Denver, Colo.

ST. LOUIS SECTION

Associate Member:
Voss, Lawrence, Southern Illinois University, Carbondale, Ill.

SAN JACINTO SECTION

Associate Member:
Saucillo, Rudolph, H. E. Bovay, Houston, Texas.

SOUTHEAST FLORIDA CHAPTER

Associate Members:
Christian, J. M., Florida Power & Light Co., Miami, Fla.
Grimme, G. R., Westinghouse Electric Corp., Miami, Fla.
Yanaros, F. E., Florida Power & Light Co., Miami, Fla.

SOUTHERN CALIFORNIA SECTION

Associate Member:
Dieffenwierth, J. H., Hollywood Wholesale Electric Co., Los Angeles, Calif.

SOUTHWESTERN SECTION

Associate Members:
Butcher, H. E., George E. Anderson Co., Dallas, Texas.
Lacy, J. N., Texas Power & Light Co., Tyler, Texas.

SUWANNEE RIVER CHAPTER

Associate Member:
Platt, R. A., General Electric Co., Jacksonville, Fla.

TAR-HEEL SECTION

Members:
*Ducker, A. L., Jr., General Electric Co., Greensboro, N. C.
*Jordan, C. C., Carolina Power & Light Co., Raleigh, N. C.

Associate Members:
Balmer, J. M., General Electric Co., Charlotte, N. C.
Cain, J. B., General Electric Supply Co., Greensboro, N. C.

TORONTO SECTION

Associate Members:
Melville, E. F., Amalgamated Electric Corp., Ltd., Toronto, Ont.
Scott, N. H., D. H. Howden Co., Ltd., London, Ont.
Sitarski, Edward, International Business Machines, Toronto, Ont.
Woods, H. G., D. H. Howden Co., Ltd., London, Ont.

TWIN CITY SECTION

Associate Members:
Braun, R. P., Fluorescent Electric, St. Paul, Minn.
Holmgren, A. G., North Central Electric Dist. Co., Minneapolis, Minn.
Walsh, W. J., Westinghouse Electric Supply Corp., Minneapolis, Minn.

(Continued on page 42A)

CONTEMPORARY LIGHTING BY

Sightsaver

STYLES FOR CHURCHES AND INSTITUTIONS

- Features R-40 Reflector Floods
- Louver Bottoms For Efficiency
- Multiple Circuit Wiring For Flexibility
- Thousands of Designs For Varied Needs

WRITE ON YOUR LETTERHEAD FOR SPECIAL RECOMMENDATIONS AND SKETCHES OR CATALOG I.

R.A. MANNING COMPANY

1810 North Ave., Sheboygan, Wis.

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where lighting quality counts . . .

Specify

MITCHELL

the finest in fluorescent for every commercial, industrial and institutional application . . .

WRITE FOR DESCRIPTIVE CATALOGS

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2525 N. Clybourn Ave., Chicago 14, Illinois

In Canada: Mitchell Mfg. Co., Ltd., 19 Waterman Ave., Toronto

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Sketch shows a Kliegl Fixed Beam Ellipsoidal Downlight unit using fixed focus optical system, providing pleasant, adequate illumination.

just off the press

New, 36 page brochure, A-11-D, contains comprehensive architectural and engineering information on Downlight, Wall Washers, Picture Lighting and other new and different lighting equipment for schools, churches, auditorium, public and commercial buildings, homes, etc. Send for your copy, today!

KLIEGL BROS

UNIVERSAL ELECTRIC STAGE LIGHTING CO., Inc.

ORIGINATORS and MANUFACTURERS of KLIEGLIGHTS

321 West 50th Street • New York 19, N. Y.

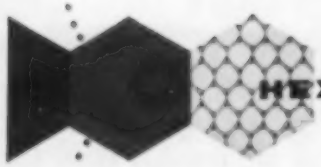
West Coast: Kliegl Lighting Company of Calif., 1060 N. 4th St., Los Angeles 17, Calif.

HONEYLITE troffer louvers in modern room housing IBM 702 electronic data processing machine at IBM's Poughkeepsie, New York, plant. Inset shows close-up of aluminum honeycomb.

IBM

CHOOSES **HONEYLITE***

. . . because of its high efficiency, low surface brightness and unusual acoustical properties. Installation was simple, inexpensive. The material used in HONEYLITE ceilings is non-combustible, and approved for suspension under fire prevention sprinkler heads. HONEYLITE is efficient, safe . . . strikingly beautiful when used in full ceilings, troffer diffusers or industrial and commercial fixtures. Additional information on request.



* HONEYLITE LIGHT-DIFFUSING ACOUSTICAL ALUMINUM HONEYCOMB CEILINGS ARE A DEVELOPMENT OF

HEXCEL PRODUCTS CO.

DEPT. I, 9451-61st STREET
OAKLAND 8, CALIFORNIA

(*Continued from page 40A*)

VIRGINIA CHAPTER

Associate Member:

Mitchel, W. A., Graybar Electric Corp., Richmond, Va.

WESTERN MICHIGAN SECTION

Member:

*Thompson, L. G., Independent Electric Co., Muskegon, Mich.

Associate Members:

McGuire, R. W., Louis C. Kingscott & Associates Inc., Kalamazoo, Mich.

Slabbekoorn, Leonard, Westinghouse Electric Corp., Grand Rapids, Mich.

WESTERN NEW YORK SECTION

Associate Member:

Hurst, G. R., Sylvania Electric Products, Inc., Buffalo, N. Y.

WINNIPEG CHAPTER

Associate Members:

de Sieyes, F., Northern Electric Co., Winnipeg, Man.

Durnin, C. E., Millen-Durnin-Parrish, Ltd., Winnipeg, Man.

Parrish, C. K., Millen-Durnin-Parrish, Ltd., Winnipeg, Man.

Thorsteinson, Eric, Green Blankstein Russell & Associates, Winnipeg, Man.

Employment Opportunities

REPRESENTATIVE AVAILABLE

Established lighting sales engineer with Architect-Engineer-Jobber following desires a line of Commercial and Industrial Lighting Fixtures, territory covered: Minnesota, North and South Dakota, Western Wisconsin. Address Box 239, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

NATIONAL SALES MANAGER WANTED

We require a national sales manager who will work in the field if necessary to pick and guide lighting sales engineers. Top caliber man, experienced in lighting and familiar with the architect, engineer and electrical jobbing trade. Connecticut lighting fixture manufacturer, established 15 years, has new, revolutionary, patented electrical product sold only on exclusive franchise. Opportunity to make high figure income. Send complete resume including present earnings. All replies strictly confidential. Address Box 240, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

SALES ENGINEERS WANTED

Connecticut manufacturer requires lighting sales engineers who are familiar with the architect, engineer and electrical jobbing trade to sell new, revolutionary, patented electrical product sold only on exclusive franchise basis. Choice territories open. Opportunity to make five-figure income. Send complete resume. All replies strictly confidential. Address Box 241, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

SALES REPRESENTATIVES WANTED

Leading manufacturer of incandescent and fluorescent lighting fixtures presently expanding into new territories requests the services of competent representatives able to call on architects, consulting engineers, electrical contractors and electrical wholesalers. Our policy is sales strictly through electrical wholesalers only. Several lucrative areas still available. Send complete resume including lines presently carried, education, experience, complete references, etc. All information and correspondence will be held in complete confidence. Interviews can be arranged. GENERAL LIGHTING PRODUCTS CO., 468 Frelinghuysen Ave., Newark 5, N. J.

SALES REPRESENTATIVE WANTED

The Miller Company is expanding its field sales force and sales positions are open in the following territories: Southern Indiana and Kentucky. Representatives interested are invited to communicate with:

Personnel Department
THE MILLER COMPANY
99 Center Street
Meriden, Connecticut

SYLVANIA'S FIXTURE GROWTH
HAS CREATED THESE OPENINGS!!!

To keep pace with present sales and future expansion plans, Sylvania's Fluorescent Fixture Operation needs men in the following classifications:

EXPERIENCED APPLICATION ENGINEERS

Men with lighting application engineering experience. For equipment layouts, preparation of technical data on lighting fixtures, and applying fluorescent and incandescent lighting to a wide variety of seeing tasks.

SALES REPRESENTATIVES

Sylvania needs sales representatives in various parts of the country to handle the increased demand for Sylvania Fluorescent Fixtures. Should be familiar with lighting applications and layouts, and experienced in contacting architects, engineers, contractors, and distributors.

DESIGNER

Man with five years experience in the design of sheet metal products. Must be able to design products for good appearance as well as mechanical operation. Must be able to assume independent design responsibility.

Mail details of age, experience and availablity to:

SYLVANIA ELECTRIC PRODUCTS, INC.
LIGHTING DIVISION
Fluorescent Lighting Fixture Operation, Dept. 39
WHEELING, W. VA.

WILEY Offers: STARTER TYPE, RAPID START AND SLIMLINE LIGHTING FIXTURES
Commercial and Industrial

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WILEY DESIGNED
WILEY MANUFACTURED

Modern, functional designs to harmonize with any architectural motif.

Stock fixtures adaptable for all lighting layouts.

Units designed for quick, easy erection; a minimum of "on the job" assembly.

Patented E-Z Servicer.

District Sales Engineers available for prompt cooperation.

Designed and Completely manufactured by WILEY, pioneers in Fluorescence since its inception — with ETL Certified Electrical Components.

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Underwriters' Approved — IBEW (A.F. of L)

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- INHERENTLY STABLE
- GREATER EFFICIENCY
- FAST RESPONSE
- FLEXIBLE LOAD CAPACITY
- REMOTE CONTROL
- SPACE SAVING EASILY INSTALLED

WRITE TODAY for new lighting control bulletin.

VICKERS ELECTRIC DIVISION
VICKERS Inc.
a unit of the Sperry Corporation
1863 LOCUST STREET • SAINT LOUIS 3, MISSOURI

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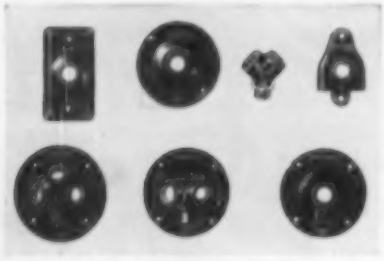
STEBER FLOODLIGHTS AND SEALED BEAM COMPONENTS

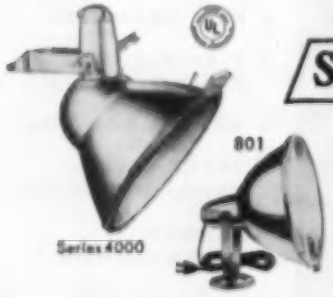
CHROME PLATED STEBERLITES WITH FITTINGS FINISHED IN RICH BLACK!



Lustre—liveliness—sales appeal! Chrome plated Steberlites have it! The brilliant plated surface of the S-500, richly contrasted by deep black weatherproof lamp gasket and mounting flanges finished in colonial black, provides that magic touch which makes a Steberlite installation outstanding. S-500 Steberlites are fully adjustable, are factory wired and accommodate PAR-38 and R-40 medium base lamps. The mounting flanges provide for easy attachment to wall or pole, switch or outlet box—in single, two or three lamp combinations.

STEBER VAPORTITE FIXTURES

Especially designed for both indoor and outdoor use. Heavy cast aluminum construction resists moisture, salt spray, smoke, non-explosive dust, gas and most chemical fumes. Extra thick cork gaskets provided for perfect seal between splice box and fixture and glass globe and fixture cap. Types for mounting to outlet box or to vertical or horizontal ½" conduit or pipe. Each unit can be furnished with welded wire guard to protect globe from breakage. For 100 or 200 watt lamp.



OPEN AND ENCLOSED STEBER FLOODLIGHTS

Economical Steber floodlights are available in both open and enclosed types for lamps from 100 to 1500 watts. Each unit has ample wiring compartment (or is fully wired with cord and plug), and versatile mounting bracket for quick, easy installation. Ideal for all industrial, commercial and sports areas.

New Steber Catalog TDS-9 gives complete details. Write now.

STEBER MANUFACTURING CO.

INDEX TO ADVERTISERS
June 1955

Advance Transformer Co.	31A
Champion Lamp Works	38A
Corning Glass Works	35A
Curtis Lighting Inc.	4A
Day-Brite Lighting Inc.	37A
E. I. du Pont de Nemours & Co. Inc.	14A
Eastern Fixture Co.	32A
General Electric Co., Apparatus	26A
General Electric Co., Lamp	19A
Edwin F. Guth Co.	Back Cover
Hexcel Products Co.	42A
Kliegl Bros.	41A
Light & Power Utilities Corp.	39A
Litecontrol Corp.	29A
R. A. Manning Co.	41A
Mitchell Manufacturing Co.	41A
RLM Standards Institute	Inside Back Cover
Rohm & Haas Co.	20A
Smithcraft Lighting Division	17A
Sola Electric Co.	13A
Starring & Company Inc	2A
Steber Manufacturing Co.	44A
Sunbeam Lighting Co.	40A
Sylvania Electric Products Inc.	23A, 43A
Vickers Lighting Division	43A
Wakefield Company	Inside Front Cover
Westinghouse Electric Corp., Lighting	1A
R. & W. Wiley Inc.	43A

New RLM Specifications for:

1. ALL-WHITE PORCELAIN ENAMEL REFLECTORS (Inside and Outside)
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NEW RLM SPECIFICATIONS BRING YOU BENEFITS LIKE THESE:

- ✓ Greater Brightness Control
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- ✓ Greater Ease of Maintenance
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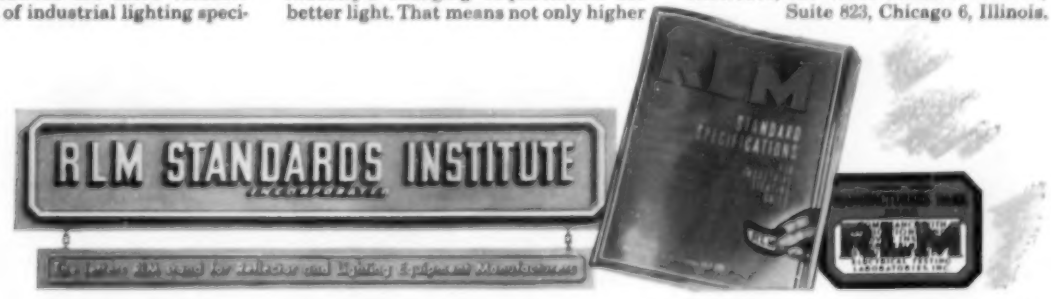
- ✓ Longer Life

Here's what these 12 ADVANCEMENTS in the NEW RLM SPECIFICATIONS mean to you in terms of BETTER INDUSTRIAL LIGHTING

The better lighting advantages listed above, highlight the many benefits that are yours as a result of the newly-established 1955 RLM Specifications for incandescent and fluorescent lighting units. With the ever-increasing importance of the right quality and quantity of light for greater efficiency in today's highly competitive industrial production, the selection of the proper lighting equipment becomes more important than ever. That is why these new 1955 RLM Specifications are more valuable than any set of industrial lighting specifications published during the RLM Standards 35-year history. That is the reason, too, why you benefit in more ways than ever before when you specify lighting units certified to carry the RLM Label. Today's RLM-labeled incandescent and fluorescent lighting equipment is made to the latest approved standards of illuminating engineering, to assure you of getting more light for your money now and for years to come. The newly-added specifications reflect American Industry's changing requirements for better light. That means not only higher footcandle levels, but also greater eye comfort . . . through greater brightness control. These, and many other advanced illuminating engineering principles are behind every RLM Label on every RLM-certified lighting unit. For a complete set of the new RLM Specifications, as well as other up-to-date lighting data, send for your free copy of the RLM Specifications Book.

Address your request to RLM Standards Institute, 326 West Madison Street, Suite 823, Chicago 6, Illinois.



R1006

the sad case of Professor Dunkle

OR . . . . . WHO WANTS TO REPLACE HIM?

Dunkle taught Economics in Room 10 for twenty-six years. After five years, he had a definite squint. On his twentieth anniversary, he asked boldly for softer lights and more of them. But the school was "economizing".

Room 10 wore the air of a tomb. Dunkle's eye trouble forced him to draw the blinds against the sun, and the lights were so high up they did nothing but shine brightly at the ceiling. Students who sometimes awakened saw only spots before their eyes.

Finally, poor Dunkle had to resign, seven years before his time — a victim of poor lighting!

At the last Board meeting, everyone asked—"**WHOM** can we get to teach in Dunkle's room?"

They have since discovered the answer: **NOBODY!**

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INSTALL SIGHT-SAVING GUTH LIGHTING NOW!
Write for name of your nearest Guth Lighting Specialist.
He'll help you work out a **plan.**

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